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Stephenson

PHO-TR300

FINAL ORBITAL WORKSHOP DATA MANAGEMENT STUDY REPORT

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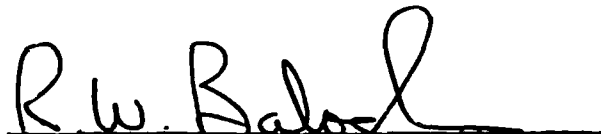
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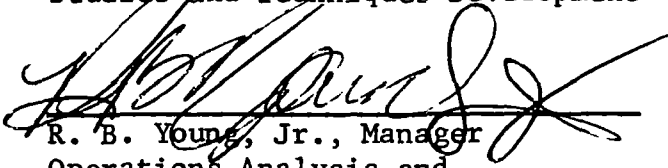
FINAL
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DATA MANAGEMENT STUDY REPORT

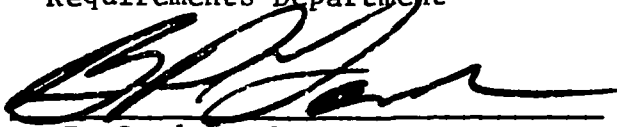
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FOREWORD

This final plan is provided under the provisions of Paragraph 1.5.A of the Statement of Work to Task Order 039a. This Task Order has been authorized by Paragraph 1.a of Part II of the Statement of Work for Schedule II of Contract NAS 9-1261.

This document is contained in two volumes. Sections 1 through 4 are contained in Volume 1, and all appendices are in Volume 2.

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APPENDIX A
OPERATIONAL MISSION GROUND RULES AND ASSUMPTIONS

A.1 GROUND RULES

The following operational mission ground rules were assumed in the preparation of this report, but because these ground rules have been assumed at this early date, some of them are likely to be modified prior to the first AAP flight.

- A. Any mission in a contingency state has priority over any other mission for all sites.
- B. The MSFN land sites will provide primary support while mobile MSFN facilities meet the program policy of flexibility in mission assignments.
- C. A given MSFN site will support only one mission at any given time. A mission may consist of many related vehicles together or in any phase or rendezvous.
- D. For support of long duration missions and multiple missions, the scheduling of remote site support must become a dynamic function, i.e., the planning and commitment of MSFN site support must be performed on an hour-by-hour basis to allow optimum use of the entire MSFN in all situations.
- E. Continuous voice, tracking, telemetry, and command coverage is required from liftoff through insertion +90 seconds.
- F. The maximum coverage gap for telemetry and voice should not exceed 3 hours.
- G. A ground contact is required with a station that is capable of updating the onboard guidance and navigation data (voice or command) prior to any burn greater than a nominal 20-second duration. This update is required no earlier than 90 minutes and no later than 30 minutes prior to the burn.

- H. CSM voice and telemetry plus SIVB/IU command and telemetry coverage is required at least 2 minutes prior to any transposition and docking maneuver.
- I. All major orbital burns require telemetry, voice, command and high-speed radar tracking. This coverage is desired commencing 2 minutes prior to ignition and continuing through cutoff +2 minutes.
- J. Telemetry and voice coverage shall be planned for the GO/NO-GO decision for any EVA or IVA.
- K. Prior to and during the deorbit burn, telemetry and voice coverage is needed. Radar tracking is required prior to blackout, and telemetry and voice coverage are highly desirable for this period.
- L. The CSM will be manned at all times.
- M. The EVA period will not exceed 3 hours per EVA.
- N. All EVA's will require two astronauts, one on EVA and one in a supporting capacity.
- O. Every 14th day of each mission will be designated a contingency day.
- P. RSDP telemetry software requirements for AAP may initiate a single multipurpose format interfacing with multiple data transmission lines. Until this concept is approved, conventional RSDP programs will be required with the following projected estimate:
 - 1. The RSDP should have the capability to store up to six HSD-size transmission formats for instantaneous callup.
 - 2. The RSDP, at every USB facility, shall have the capability of storing up to 30 HSD-size transmission formats for reading into the RSDP output transmission format memory in order to replace any or all of the above six formats within 15 minutes.

3. Six duplex HSD circuits to each prime MSFN site are the estimated requirement for supporting AAP-1/AAP-2.

A.2 ASSUMPTIONS

The following assumptions were used in the preparation of this report:

- A. Single USB sites will be expected to provide the minimum simultaneous PCM telemetry support as defined below:

	<u>USB PM</u>	<u>USB FM</u>	<u>VHF</u>
• Real-Time Processing Links	1(or 2)	1	0-3
• Receive and Record Links	1(or 2)	1	4

- B. Dual USB sites will be expected to provide the minimum simultaneous PCM telemetry support as defined below:

	<u>USB PM</u>	<u>USB FM</u>	<u>VHF</u>
• Real-Time Processing Links	2	2	0-3
• Receive and Record Links	2	2	4

- C. Both single and dual USB sites will be required to simultaneously process and forward to MCC-H at least three of the independent telemetry links via the PCM stations at a given time.

- D. Onboard communications systems requiring a ground support interface are outlined below:

	<u>CSM</u>	<u>LM</u>	<u>ATM</u>	<u>IU(1)</u>	<u>Airlock</u>	<u>Total</u>
Command	USB	USB	UHF	UHF	UHF	5
Real-Time TLM	USB	USB (2)	VHF	VHF	VHF	4-5
Dump TLM	USB	USB (2)	VHF	-	VHF	3-4
Voice (3)	USB VHF	USB VHF	-	-	VHF	3
Tracking (4)	C-band USB	USB	-	C-band	-	2-4

- E. SIVB/IU support will be limited to a maximum of five revolutions.
- F. The planned implementation of the remote sites will be completed in time for supporting the AAP mission.
- G. The resupply module, even if flown, will not require a separate data downlink.
- H. The remote site decommutators have selectable formats.
- I. Only one major experiment will be performed at any one time and, consequently, only one experiment will require real-time monitoring and support at that time.

APPENDIX B

ANALYSIS OF MCC-H SUPPORT FUNCTIONS

B.1 GENERAL

This appendix is based on the MCC-H configuration presented in PHO-TR155 (AS-501 and AS-202), MCC-H Operational Configuration for MOCR-1 (red binder) and MOCR-2 (green binder). Because the MCC-H is in a constant state of change in order to support new requirements, this appendix should not be used as an exact representation of the MCC-H, but rather to give insight into the basic capabilities currently in existence.

At present, the MCC-H is configured into two main control areas. Certain areas (to be noted later) on each floor are shared, but basically, one control area is centered on the third floor and another on the second floor. Current control philosophy states that lunar missions and experiments will be controlled from the third floor and earth-orbital missions and experiments from the second floor.

Each floor contains one MOCR and six SSR's which are basically configured the same except for certain minor differences which involve the support of the two types of missions. Each floor also has a set of group displays, digital display drivers, and simulation control.

Areas on the second and third floors that are shared by the control groups are as follows:

A. Third Floor

- D/TV Converter Slide File Channels
- Recovery Control
- Meteorological Center
- Network SSR

B. Second Floor

- Simulation Equipment
- Simulated Remote Sites (2 Gemini type)
- Mission Scheduling Office

The Network SSR will be deleted in the near future, and the functions of Consoles 21 and 25 are to be redefined. Also, the possibility exists that one of the Gemini remote sites will be moved from Bldg. 30 to Bldg. 422; the other will be deleted.

The first floor contains the RTCC which is also shared by the control groups. The RTCC contains three IBM 360-75 computers and one IBM 7094 computer, plus peripheral equipment. The 7094 will be replaced by another 360-75 at some future date. There are 64 D/TV converter slide file channels, 32 of which are assigned to each floor and 4 of which are for displaying reference data only. In addition, Recovery Control has a separate slide file for classified reference slides to be accessed only by Recovery Control personnel.

B.2 MCC-H CONSOLE ALLOCATION

There are 113 consoles located throughout the MCC-H devoted to operational mission support. An additional 13 are used for simulation control which are not enumerated in this appendix.

Tables B-1 and B-2 list consoles by control group assigned and by room location. Console allocation is as follows:

<u>Third Floor</u>			<u>Second Floor</u>		
MOCR 1	18		MOCR 2	18	
SSR's	25	(5 shared)	SSR's	25	
RTCC	12	(3 shared)	RTCC	12	
Other	10	(9 shared)	Other	10	

MODULES			KEYBOARDS				INPUT AND CONTROL														OUTPUT AND MONITORING																																									
			DRK	FDK	MSK	SMEK	ABORT LIGHT AND RTC	ABORT LIGHT OFF CMD RECEIVED	ABORT RESET	CARDIOSCOPE CONTROL	EVENT SEQUENCE OVERRIDE	INDICATOR SWITCH	PAN TILT CONTROL	PAD TV OUTPUT ENABLE	PROJECTION TV CONTROL	REMOTE RTA CONTROL	SWITCH MODULE	SPECIAL TV MONITOR SWITCH	TV MONITOR SELECT	TV NETWORK SELECT	VOICE COM	ZOOM CONTROL	ABORT REQUEST	ABORT LIGHT	CONSOLE SPEAKER	CONSOLE SITE INDICATOR	CONSOLE TELETYPE	CARDIOSCOPE DISPLAY	CONSOLE ANALOG METERS	CLOCK 7-DIGIT	CLOCK 6-DIGIT	DUAL 8" TV MONITOR	EVENT INDICATOR	HOLD PROCEED	PRECISION 14" TV MONITOR	STATUS REPORT	STATUS STATUS REPORT	STOP CLOCK	UTILITY 14" TV MONITOR																							
NO.	POSITION NAME	ROOM NO.																																																												
01	OPERATIONS DIRECTOR	330			1															2		1											1	2																												
02	FLIGHT DIRECTOR	330			1		1	1	1											2				1								1		2																												
03	ASSISTANT FLIGHT DIRECTOR	330			1															1					1	1					1		2	1																												
04	OPERATIONS AND PROCEDURES OFFICER	330			1															1						1							2		1																											
05	LIFE SYSTEMS OFFICER	330			1				1											2							1	1 (4)				1		2		1																										
06	SPACECRAFT COMMUNICATOR	330			1					2										1									1	1				2		1	1																									
07	CSM EECOM ENGINEER	330	1		1	1								3						1								1 (15)				5		2		1																										
08	CSM GNC ENGINEER	330	1		1	1								2						1												2		2		1																										
09	LM CONTROL ENGINEER	330	1	1	1	1														2								1 (15)				2		2		1																										
10	BOOSTER SYSTEMS ENGINEER	330			1	1								3						2			1						1			5		3		1																										
11	FLIGHT DYNAMICS OFFICER	330	1	2	1					2										1			3							1	1				2		1																									
12	GUIDANCE OFFICER	330	1		1						2					4				2										1	1				2		1																									
13	RETROFIRE OFFICER	330	1		1											2				1										2	1				2		1	2																								
14	PUBLIC AFFAIRS OFFICER	330			1							1	1				1	1		2	1											1																														
15	DOD REPRESENTATIVE	330			1														1	2		1												2				1																								
16	LM GNC ENGINEER	330	NOT DEFINED																																																											
17	FLIGHT ACTIVITY AND EXPERIMENT	330			1															2															2		1																									
18	INSTRUMENTATION COORDINATOR	330			1							1		1	1					2	1			1								1		2		1																										
SUBTOTALS			6	3	17	4	1	1	1	1	4	2	2	1	1	1	14	1	1	1	27	2	2	4	2	1	2	1	3	7	4	1	18	1	34	1	12	3	1																							

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TABLE B-1 MOCR-1 MODULE ALLOCATION
(MOCR CONSOLES) (1 OF 3)

MODULES			KEYBOARD		INPUT AND CONTROL							OUTPUT AND MONITORING									
			FDK	MSK	CARDIOSCOPE CONTROL	EVENT SEQUENCE OVERRIDE	PAN TILT CONTROL	SWITCH MODULE	SPECIAL SWITCH	VOICE COM	ZOOM CONTROL	CONSOLE SPEAKER	CARDIOSCOPE DISPLAY	CONSOLE ANALOG METERS	CHART RECORDER	CLOCK 7-DIGIT	CLOCK 6-DIGIT WITH SWITCH	EVENT INDICATOR	PRECISION 14" TV MONITOR	STATUS REPORT	TV SOURCE
Life S-151 SSR	19	AEROMED SPEC		1	1					2			1	1 (4)	1				2	2	
	20	ENVIRONMENTAL SPEC	312	1	1					2		1			1			3	2	2	
	21	EXPERIMENT SPEC	312A	← NOT DEFINED →																	
	81	CSM SPACECRAFT ANALYSIS	312A		1						2		1						3	3	
E-10 SSR	82	LM SPACECRAFT ANALYSIS	312A		1					2		1						3	3		
	22	FLIGHT PLAN SPEC	313		1					2		1							2		
F-1 Dir SSR	23	INFORMATION FLOW COORDINATOR	313		1					2		1							2	2	
	24	FLIGHT CONTROL COORDINATOR	313		1					2		1							2	2	
Mach 10 SSR	25	CMD AND DATA PROCESS	314		1					2		1							2		
	26	RADAR CONTROL 1 AND 2	314		2					2		1						2	2	2	2
	27	COMPUTER AND COMM SYSTEM	3,4		2					2		1						2	2	2	2
	28	TEAM CHIEF	314		2					2		1						2	2	2	2
Veh Spt SSR	71	TELEMETRY AND RF SYSTEMS	314		2					2		1						2	2	2	2
	29	LM SPECIALIST	311		2					1	3			1 (15)	1		1	10	4	3	
	30	LM SUPPORT SPECIALIST	311		1				1		2		1	1 (15)				4	2	2	
	31	CSM EECOM SUPPORT SPEC	311		1				1		2		1		1			11	2	2	
	32	CSM GNC SUPPORT SPEC	311		1						2		1					5	2	2	
	33	BOOSTER SUPPORT SPEC	311	1	1						2		1	1 (15)				4	2	2	
	34	BOOSTER SUPPORT SPEC	311	1	1						2		1	1 (15)	1			4	2	2	
	35	RETROFIRE SUPPORT SPEC	310		1						1					1			2	1	
	36	FLIGHT DYNAMICS SUPPORT SPEC	310		1		2	1			1	1	1					1	2		
	37	GUIDANCE SUPPORT SPEC	310		1						2								1	2	1
F-1 D/H SSR	38	AUXILIARY FLIGHT DYNAMICS SPEC	310		1					2									2	1	
	39	AUXILIARY FLIGHT DYNAMICS SPEC	310		1					1		1							2	1	
	40	AUXILIARY FLIGHT DYNAMICS SPEC	310		1						1				2				2	1	
SUBTOTALS			3	29	1	2	1	2	1	45	1	18	1	5	7	1	1	57	52	34	8

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TABLE B-1 MOCR-1 MODULE ALLOCATION (SSR CONSOLES) (2 OF 3)

MODULES			KEYBOARDS				INPUT AND CONTROL														OUTPUT AND MONITORING																			
			DRK	MSK	PCK	SMEK	ABORT LIGHT AND RTC	ABORT RESET	ABORT LIGHT OFF CMD RECEIVED	CARDIOSCOPE CONTROL	EVENT SEQUENCE OVERRIDE	INDICATOR SWITCH	PAN TILT CONTROL	PAD TV OUTPUT ENABLE	PROJECTION TV CONTROL	REMOTE RTA CONTROL	SWITCH MODULE	SPECIAL TV MONITOR SWITCH	TV MONITOR SELECT	VOICE COMM	ZOOM CONTROL	ABORT REQUEST	ABORT LIGHT	CONSOLE SPEAKER	CONSOLE SITE INDICATOR	CONSOLE TELETYPE	CARDIOSCOPE DISPLAY	CONSOLE ANALOG METERS	CLOCK 7-DIGIT	CLOCK 6-DIGIT	CLOCK 6-DIGIT WITH SWITCH	DUAL 8" TV MONITOR	EVENT INDICATOR	HOLD PROCEED	PRECISION 14 TV MONITOR	STATUS REPORT	STATUS STATUS REPORT	STOP CLOCK	USB STATION CONFIG DISPLAY	
NO.	POSITION NAME	ROOM NO.																																						
01	OPERATIONS DIRECTOR	231		1															2		1												1	2						
02	FLIGHT DIRECTOR	231		1			1	1	1										2				1					1				2		2						
03	ASSISTANT FLIGHT DIRECTOR	231		1															1					1	1						1		2	1						
04	OPERATIONS AND PROCEDURES OFFICER	231		1															1						1								2		1					
05	LIFE SYSTEMS OFFICER	231		1					1										2							1	1 (4)					1		2		1				
06	SPACECRAFT COMMUNICATOR	231		1						1									1									1	1				2		1	1				
07	CSM EECOM ENGINEER	231	1	1		1										3			1								1 (15)					5		2		1				
08	CSM GNC ENGINEER	231	1	1		1													1								1 (15)					4		2		1				
09	LM CONTROL ENGINEER	231	1	1		1										3			1												4		2		1					
10	BOOSTER SYSTEMS ENGINEER	231		1		1										3			2			1						1			5		3		1					
11	FLIGHT DYNAMICS	231	1	1	2					2									1			3						1	1					2		1				
12	GUIDANCE OFFICER	231	1	1							2					4			2														2		1					
13	RETROFIRE OFFICER	231		1												2			1									2	1					2		1	2			
14	PUBLIC AFFAIRS OFFICER	231		1								1	1				1	1	2	1											1			1						
15	DOD REPRESENTATIVE	231		1															2		1													2						
16	LM GNC ENGINEER	231	1	1		1										4			1													8		2		1				
17	FLIGHT PLAN/ EXPERIMENT ACTIVITY	231		1															2											1					2		1			
18	NETWORK CONTROL	231		2								1		1	1		1		2	1			1											3		1			1	
SUBTOTALS			6	19	2	5	1	1	1	1	3	2	2	1	1	1	19	2	1	27	2	2	4	2	1	2	1	3	6	3	2	1	30	1	37	1	13	3	1	

A5528 (D)

TABLE B-2 MOCR-2 MODULE ALLOCATION
(MOCR CONSOLES) (1 OF 3)

MODULES			KEY BD	INPUT AND CONTROL								OUTPUT AND MONITORING									
				MSK	CARDIOSCOPE CONTROL	EVENT SEQUENCE OVERRIDE	PAN TILT CONTROL	SWITCH MODULE	SPECIAL SWITCH	TV SOURCE	VOICE COM	ZOOM CONTROL	CONSOLE SPEAKER	CARDIOSCOPE DISPLAY	CONSOLE ANALOG METERS	CHART RECORDER	CLOCK 7-DIGIT	CLOCK 6-DIGIT WITH SWITCH	EVENT INDICATOR	PRECISION 14" TV MONITOR	STATUS REPORT
NUMBER	POSITION NAME	ROOM NO.																			
19	AEROMEDICAL SPECIALIST	212	1	1					2		1	1	1 (4)	1			1	2	2		
20	ENVIRONMENTAL SPECIALIST	212	1						2		1			1			2	2			
81	CSM SPACECRAFT ANALYSIS	21A	1						2		1						3	3			
82	LM SPACECRAFT ANALYSIS	21A	1						2		1						3	3			
21	EXPERIMENT PROJECT OFF.	213	1						2		1							2	2		
22	EXPERIMENT SUPPORT	213	1						2		1							2	2		
23	FLIGHT PLAN SUPPORT	213	1						2		1							2	2		
24	INFORMATION FLOW COORDINATE	213	1						2		1							2	2		
25	COMMAND DATA PROCESSING COORDINATE	314	2				2		2		1							2	2		
26	RADAR CONTROLLER 1 AND 2	314	2						2	2	1						2	2	2		
27	COMPUTER AND COMMUNICATIONS SYSTEM	314	2						2	2	1						2	2	2		
28	TEAM CHIEF	314	2						2	2	1						2	2		2	
71	TELEMETRY AND RF SYSTEMS	314	2						2	2	1						2	2	2		
29	LM GNC SPECIALIST	211	2					1		2		1 (15)	1		1	10	4	3			
30	LM SUPPORT SPECIALIST	211	1				1			2	1	1 (15)	1			4	2	2			
31	CSM EECOM SUPPORT SPEC	211	1				1			2	1		1			11	2	2			
32	LM EECOM SPECIALIST	211	1							2	1		1			5	2	2			
33	BOOSTER SUPPORT SPECIALIST	211	1							2	1		1			4	2	2			
34	BOOSTER SUPPORT SPECIALIST	211	1							2	1		1			4	2	2			
35	RETROFIRE SUPPORT SPEC	210	1							1				1			2	1			
36	FLIGHT DYNAMICS SUPPORT SPECIALIST	210	1		2	1				1	1	1				1	2	1			
37	GUIDANCE SUPPORT SPEC	210	1							2						1	2	1			
38	AUXILIARY FLIGHT DYNAMICS SUPPORT	210	1							1							2	1			
39	AUXILIARY FLIGHT DYNAMICS SUPPORT	210	1							1	1						2	1			
40	AUXILIARY FLIGHT DYNAMICS SUPPORT	210	1							1	1						2	1			
SUBTOTALS			31	1	2	1	4	1	8	45	1	21	1	3	8	1	1	57	34	39	2

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TABLE B-2 MOCR-2 MODULE ALLOCATION (SSR CONSOLES) (2 OF 3)

TABLE B-2 MOCR-2 MODULE ALLOCATION
(OTHER CONSOLES) (3 OF 3)

When the same "shared area" console number is assigned to each floor, it is patched to one floor or the other depending upon the real-time requirement for its support. The number 45A indicates this console is assigned to the third floor and a similar console, 45B, is assigned to the second floor. Consoles 57A through 57H are not listed but are located in Recovery Control. These consoles are communication positions for the DOD only.

B.3 DELINEATION OF CONTROL FUNCTIONS BY MODULE

There are approximately 1489 modules installed on consoles throughout the MCC-H. Seventy-two different modules offering 187 options are currently being used. Approximately 80 percent of the modules have input and output capability, but 42 are used for input and control, 30 are used for output and monitoring, and 7 are used as keyboards. Table B-3 is an alphabetical listing of modules now in use showing the number of options per module and the number of each module used in each control group. It also presents a brief description of the functions of each module and shows that with one exception, the Precision 14" TV monitor, the modules that appear with the highest frequency are those that have the highest number of options.

Each multioption module has a configuration on a given option whose capability equals or exceeds that of all other options for this module.

Tables B-1 and B-2 summarize the module allocation per console. There are approximately 33 modules which appear on only one console and are used for a specific function that does not vary with changing mission requirements. These modules are located in "behind the scenes" areas.

There are seven modules that appear on consoles in the MOCR's, SSR's, and Recovery Control. These modules are as follows:

- Console Analog Meters
- DRK
- SMEK

TABLE B-3
MODULE FUNCTIONS

MODULE NAME	OPTIONS	NUMBER IN USE		FUNCTION
		MOCR1	MOCR2	
ABORT REQUEST	1	4	3	INDICATES AN ABORT HAS BEEN REQUESTED
ABORT LIGHT AND REAL-TIME COMPUTER	1	1	1	{ MODULES USED TO SEND AND MONITOR CMD'S IN CONJUNCTION WITH THE MDCS (BEING PHASED OUT)
ABORT RESET	1	1	1	
ABORT LIGHT	1	4	5	SWITCH THAT INITIATES ABORT CMD AND INDICATES SUCH
ABORT LIGHT OFF COMMAND RECEIVED	1	1	1	VERIFIES ABORT CMD RECEIVED
CONSOLE SPEAKER (COMSPK)	2	24	26	VOICE INTERCOM SPEAKER
CONSOLE SITE INDICATOR	1	1	1	INDICATES WHICH CMD PANEL IS ACTIVE AND TO WHICH SITE
CONSOLE TELETYPE (STTY)	1	5	5	RECEIVE ONLY. PRESENTS PRE-SELECTED PORTIONS OF TELETYPE DATA
CARDIOSCOPE DISPLAY	1	2	2	DISPLAYS STERNAL EKG, AXILLARY EKG, RESPIRATION
CARDIOSCOPE CONTROL	1	2	2	CONTROL UNIT FOR CARDIOSCOPE TRACES
CONSOLE ANALOG METERS	2	6	6	<u>ANALOG METERS</u> • Various Pressure Measurements • Various Temperature Measurements

TABLE B-3 (CONT'D)

MODULE NAME	OPTIONS	NUMBER IN USE		FUNCTION
		MOCR1	MOCR2	
CHART RECORDER	1	10	8	• Various Current Measurements • Various Voltage Measurements • Vehicle Attitudes and Rates • Various Gimble Positions • Various Valve Positions <u>CHART RECORDER</u> • Sternal EKG • Axillary EKG • Respiration • Various Pressure Measurements • Various Temperature Measurements • Various Current Measurements • Various Voltage Measurements
CAMERA CONTROL UNIT (CCU) REMOTE CONTROL	1	34	34	REMOTE CONTROL OF D/TV CAMERAS
CRITICAL COMPONENT	1	1	1	CONTROLS IDENTIFICATION AND ISOLATION OF FAULTY DISPLAY EQUIPMENT
COMPUTER TRANSFER	1	1	1	INITIATES TRANSFER FROM MOC TO DSC

TABLE B-3 (CONT'D)

MODULE NAME	OPTIONS	NUMBER IN USE		FUNCTION
		MOCR1	MOCR2	
CONSOLE/SITE SELECT	1	1	1	SELECTS WHICH CMD PANEL IS ACTIVE AND TO WHICH SITE
CLOCK: 7-DIGIT	1	9	8	DISPLAYS GMT
CLOCK: 6-DIGIT	1	5	4	DISPLAYS GET AND COMPUTER DERIVED TIMES SUCH AS TIME TO RETROFIRE
CLOCK: 6-DIGIT WITH SWITCH	1	1	3	DISPLAYS COUNTDOWN 1 OR 2
COMMUNICATIONS DISPLAY CONTROL	1	1	1	CONTROLS COMMUNICATION LINES STATUS INDICATION
DISPLAY REQUEST KEYBOARD (DRK)	2	7	7	MODULE FOR SELECTING DISPLAYS BY NAME
DUAL 8-INCH TV MONITOR	1	1	1	TWIN 8-INCH TV MONITORS USED TO DISPLAY COMMERCIAL NETWORK PROGRAMMING
DAYLIGHT/DARK DISPLAY	1	1	1	CONTROLS DAYLIGHT/DARK INDICATOR PROJECTOR
DRUM WRITE/INHIBIT	1	1	1	CONTROLS MEMORY DRUM
DRUMMER CONTROL	1	1	1	ILLUMINATION CONTROL
EVENT INDICATOR	24	106	118	LIGHTS WHICH ARE CONTROLLED BY EVENTS OCCURRING IN THE EQUIPMENT
				<u>EVENT INDICATORS</u>
				● Mission Events (Liftoff, Main Chute Deploy)

TABLE B-3 (CONT'D)

MODULE NAME	OPTIONS	NUMBER IN USE		FUNCTION
		MOCR1	MOCR2	
				• System Events (BECO, F/C 1 ON) • System Status • Limit Sensing • Equipment Status
EVENT SEQUENCE OVERRIDE	3	6	5	MANUAL CONTROL OF AUTOMATIC SEQUENCES
FORCED DISPLAY KEYBOARD	2	5	1	LIMIT SENSING MODULE WHICH INDICATES PERTINENT DISPLAY FORMAT
FAULT ALARM	1	1	1	INDICATES MALFUNCTION
HOLD/PROCEED	1	1	1	INDICATES AND CONTROLS HOLD/PROCEED PORTION OF GROUP DISPLAYS
HIGH-SPEED DATA INPUT	1	1	1	CONTROLS DATA INPUT TO COMPUTER
HSD SCS ACTIVITY INDICATOR	1	2	2	INDICATES STATUS OF DATA LINES
INDICATOR/SWITCH	1	4	8	SWITCH THAT VERIFIES ITS ACTION
KEYBOARD SELECT	1	1	1	ENABLES A PARTICULAR KEYBOARD (MED) TO INPUT TO THE COMPUTER
LOW-SPEED DATA TRANSMISSION	1	2	2	CONTROLS RECEIPT AND QUALITY VERIFICATION OF LOW-SPEED TLM DATA
LOW-SPEED DATA OUTPUT	1	2	2	CONTROLS TLM TELETYPE TRANSMISSION FROM RTCC TO MSFN
LOAD NUMBER INDICATOR	1	1	1	INDICATES CMD LOADS TRANSMITTED TO SITES

TABLE B-3 (CONT'D)

MODULE NAME	OPTIONS	NUMBER IN USE		FUNCTION
		MOCR1	MOCR2	
LOGIC CONTROL	1	2	3	CONTROLS DIFFERENTIAL CORRECTIONS ON VEHICLE LOW-SPEED TRACKING DATA
LAUNCH TRAJECTORY SELECT	1	1	1	CONTROLS HIGH-SPEED TRAJECTORY INPUT TO MOCR
MANUAL ENTRY DEVICE (MED)	1	3	3	TYPEWRITER TYPE KEYBOARD INPUT TO COMPUTER
MANUAL SELECT KEYBOARD (MSK)	49	66	71	MODULE FOR SELECTION OF DISPLAYS AND TV CHANNELS BY NUMBER
PRECISION 14-INCH TV MONITOR	1	115	129	PRECISION 14-INCH TV MONITOR WHICH PRESENTS D/TV DISPLAYS, AND 32 CHANNELS OF CLOSED CIRCUIT TV
PHASE CONTROL KEYBOARD (PCK)	3	1	2	CONTROLS PHASE OF COMPUTER PROGRAM
PAN/TILT CONTROL	1	7	7	CONTROLS PAN/TILT CAPABILITY OF A GROUP DISPLAY CAMERA
PAO TV OUTPUT ENABLE	1	1	1	ENABLES TV OUTPUT TO PRESS SITE
PROJECTION TV CONTROL	2	2	2	CONTROLS VIDEO PRESENTATION OF TV PROJECTORS
PRINTER INDICATOR	1	1	1	INDICATES PRINTER OPERATION
REMOTE RELATIVE TIME ACCUMULATOR (RTA) CONTROL	1	1	1	REMOTE CONTROL FOR THE RTA
REFERENCE FILE KEYBOARD (RFK)	1	1	1	MODULES FOR SELECTION OF REFERENCE SLIDE DISPLAYS

TABLE B-3 (CONT'D)

MODULE NAME	OPTIONS	NUMBER IN USE		FUNCTION
		MOCR1	MOCR2	
RTCC DCS TRANSMIT	3	3	3	CONTROLS TRANSMISSION OF CMD LOADS PREPARED BY RTCC
STATUS REPORT	1	40	48	REPORTS CONSOLE OR SSR STATUS TO SUPERVISORY CONSOLE
STATUS/STATUS REPORT	1	14	15	MONITORS STATUS OF SEVERAL CONSOLES AND REPORTS TO SUPERVISORY CONSOLE
STOP CLOCK	1	3	3	MANUALLY OR EVENT CONTROLLED STOP WATCH (4-DIGIT READOUT)
SUMMARY MESSAGE ENABLE KEYBOARD	2	4	5	ENABLES DATA SAMPLING AND ASSEMBLY INTO MESSAGES
SWITCH MODULE	9	40	44	SERIES OF SWITCHES USUALLY WITH INDICATOR CAPABILITY
SPECIAL TV MONITOR SWITCH	1	2	3	SELECTS NBC, CBS, OR ABC PROGRAMMING FOR VIEWING ON A MONITOR
SPECIAL SWITCH	1	1	1	SPLIT BUTTON SWITCH
SYSTEM CONFIGURATION CONTROL	1	1	1	CONTROLS CCATS PERIPHERAL EQUIPMENT STATUS
SYSTEM CONFIGURATION DISPLAY	1	1	1	DISPLAYS CCATS PERIPHERAL EQUIPMENT STATUS
SCANNER SELECT	1	1	1	CONTROLS AND INDICATES RTCC/CCATS ADAPTER STATUS
TV MONITOR SELECT	1	4	4	SELECTS VIDEO CHANNEL TO BE MONITORED

TABLE B-3 (CONT'D)

MODULE NAME	OPTIONS	NUMBER IN USE		FUNCTION
		MOCR1	MOCR2	
TV EDIT SWITCHER	1	2	2	EDITS VIDEO OUTPUT TO FOD AUDITORIUM AND PAO REMOTE STUDIO
TV NETWORK SELECT	1	2	1	SELECTS NBC, CBS, OR ABC PROGRAMMING FOR VIEWING ON A MONITOR
TV SOURCE	1	8	9	CONTROLS FLOOR INDICATION
TELEMETRY DATA SELECT AND DISPLAY	1	1	1	SELECTS AND DISPLAYS TLM WORDS
TELEMETRY OUTPUT DATA SELECT	2	1	1	CONTROLS DATA TRANSMISSION FROM BUFFER TO RTCC
TELEMETRY INPUT SELECT AND DISPLAY	1	5	5	CONTROLS INDICATION OF DATA VALIDITY
TELETYPE SCS ACTIVITY	1	2	2	INDICATES LOW-SPEED COMMUNICATIONS LINE TERMINAL ACTIVITY
UTILITY 14-INCH TV MONITOR	1	5	4	525 SCAN LINE 14-INCH TV MONITOR USED TO DISPLAY COMMERCIAL PROGRAMMING
UCLT 33/22 ACTIVITY INDICATOR	1	1	1	INDICATES UNIVERSAL COMMUNICATIONS LINE ACTIVITY
USB STATION CONFIGURATION CONTROL	1		2	CONTROLS STATION STATUS INDICATION
USB STATION CONFIGURATION DISPLAY	1		1	DISPLAYS STATION STATUS
VOICE COMMUNICATIONS	16	104	104	VOICE COMMUNICATION WITHIN THE CENTER AND WITH THE MSFN
VIDEO ENGINEER SELECT	1	1	1	SELECTS INPUT OF OUTPUT CHANNEL OF VSM OR AVSM TO BE MONITORED

TABLE B-3 (CONT'D)

MODULE NAME	OPTIONS	NUMBER IN USE		FUNCTION
		MOCR1	MOCR2	
VIDEO JACK STRIP	1	4	4	ALLOWS PATCHING INTO D/TV CHANNELS
VEHICLE ACQUISITION	1	1	1	INDICATES SITE IN CONTACT WITH WHICH VEHICLE
VIDEO TAPE RECORDER (VTR) CONTROL	1	2	2	REMOTE CONTROL OF VTR
WAVEFORM MONITOR	1	3	3	MONITOR VIDEO OUTPUT QUALITY
ZOOM CONTROL	1	7	7	ZOOM CONTROL FOR A GROUP DISPLAY CAMERA

- Chart Recorder
- Status Report
- Status/Status Report
- Console Speaker

These are some of the modules that require most of the reconfiguration between missions. Tables B-1 and 2 show seven modules which appear in all areas on nearly every console, i.e., Precision 14" TV, MSK, and Voice Comm. With the exception of the Precision 14" TV monitor, these are multioption.

Most modules are a PBI type including modules that may be only pushbutton or indicator light or a combination. The trend is to replace toggle switches with pushbuttons as the flight controllers prefer pushbuttons.

B.4 NUMBER OF DISPLAY FORMATS BY SUPPORT FUNCTION

The most versatile and demanding of the computer-driven displays is the D/TV system. A normal single-vehicle earth-orbit mission generates the requirement for 250 D/TV displays, 90 projection plot displays, and 13 x-y plotboard displays. The expansion of these display requirements to support a dual-vehicle earth-orbit mission requires 486 D/TV displays, 110 projection plot displays, and 15 to 20 x-y plotboard displays.

—The projection plot and x-y plotboard displays increase very little, but the D/TV requirements double and result in an overload of RTCC core memory and lead time for programming the requirements.

The following are contributing factors for the overload condition:

- A. There is a large amount of redundancy in the displays since certain information is presented on several displays. For instance, a particular system will be displayed in a schematic and also in tabular form.

- B. Display capabilities have not been optimized. Paging tabs are a standard format where the same basic information is displayed using three slides. Reducing this to two pages saves 80 percent of core memory necessary to store the low-speed data for paging tabs.
- C. The RTCC stores in core memory data going back for five or more revolutions. Such information is history for most uses associated with real-time mission support.
- D. Most plots are updated once per second. There is some question as to whether the accuracy would be significantly degraded by updating every third second. This would result in saving one-third of the allocated memory.

FCD and FSB have reevaluated overall mission display requirements with the idea to provide maximum display of information and to optimize the use of core memory capability. The results are as follows:

- Selective reduction of certain display format types
- Selective reduction of data to be stored in memory
- Selective reduction of certain computations such as fuel remaining, moonrise, moonset
- Selective elimination of certain displays
- Elimination of secondary limit sensing
- Selective reduction of certain projection plot displays
- Elimination of x-y plotboard displays for reentry.

The number of D/TV displays for each MSK group for AS-205, AS-502 (single-vehicle), and AS-258 (dual-vehicle) before and after the reevaluation is presented in Table B-4. The number of displays has almost doubled from single-vehicle mission support to multivehicle mission support. Optimized utilization of display capabilities has made this possible.

TABLE B-4
D/TV DISPLAYS FOR EACH MSK GROUP

GROUP	MSK RANGE	NUMBER OF DISPLAYS			
		AS-205	AS-502	AS-258	AS-258 (REEVALUATED)
FLIGHT DYNAMICS	0001 to 0199	17	16	28	25
GUIDANCE	0200 to 0299	23	20	30	38
RETRO FIRE	0300 to 0399	17	9	23	20
EECOM	0400 to 0680	82	79	89	59
GNC	0681 to 0999	90	68	96	95
LM	1000 to 1399	0	0	121	73
BOOSTER	1400 to 1449	14	16	16	16
RECOVERY	1450 to 1459	1	1	2	5
NETWORK	1480 to 1499	19	19	6	6
S/C COMM	1500 to 1569	8	2	21	17
RTCC	1570 to 1629	17	16	23	25
LIFE SYSTEMS	1700 to 1750	0	0	0	22
OPS AND PROC	2000 to 2019	0	0	31	0
TOTAL		288	246	486	401

B.5 CONSOLE UTILIZATION VERSUS MISSION TIMELINE

The activity level during a mission fluctuates from very high during ascent to very low during the sleep periods. Console utilization during high-activity periods is discussed in this subsection. A comparison of consoles actively monitoring an AAP mission and a lunar mission as the missions progress through their various phases is presented in Tables B-5 and B-6.

Certain systems consoles are inactive while the vehicles they support are inactive, and some functions are not required during various phases. The AAP mission has six affected consoles while the lunar mission has five. Both missions have 13 consoles which are continuously active during all high-activity phases of both missions. The only exception is the Retrofire Officer's console which may not be deemed necessary during the lunar stay.

During the AAP time frame there are three lunar missions scheduled which will carry ALSEP's. Each lunar mission, which is approximately 10 days long, will have a total of 76 hours of high activity, i.e., 228 hours for all three. The AAP has only a total of 36 hours of high activity which is spread out over two periods—one 28 days and another 56 days in length.

The Booster Systems Engineer console is active only during boost periods which can extend to a maximum of 7.5 hours into a mission. The console is active for the same amount of time whether it is a lunar launch or an AAP launch, but the percent utilization is much greater on AAP missions than on lunar missions due to a much smaller number of high-activity hours in the AAP. The LM consoles are active for a relatively short time during the OWS. Utilization is much greater on lunar missions. The Flight Activity and Experiments Officer console is active intermittently for short periods during high-activity periods of the AAP, but it becomes active during lunar stay and remains so throughout the rest of the mission to support ALSEP. The DOD representative remains relatively inactive except at times of launch and reentry and, therefore, is utilized a very small part of the time on either mission.

MISSION PHASE MOCR POSITION	AAP-1 ASCENT TO ORBIT	CSM SEPARATION AND TRANSPPOSITION	CSM DOCKING WITH M&SS	2 ORBIT COAST	AAP-2 ASCENT TO ORBIT	CSM/M&SS RENDEZVOUS WITH OWS	M&SS DOCKING WITH OWS	CSM/M&SS/OWS COAST	CSM SEPARATION RETROFIRE ENTRY	AAP-3 ASCENT TO ORBIT	CSM SEPARATION AND COAST	AAP-4 ASCENT TO ORBIT	CSM SEPARATION TRANSPPOSITION DOCKING WITH LM/ATM	CSM/LM/ATM RENDEZVOUS WITH OWS	LM/ATM DOCKING WITH OWS	CSM DOCKING WITH OWS	CSM SEPARATION RETROFIRE ENTRY
OPERATIONS DIRECTOR																	
FLIGHT DIRECTOR																	
ASSISTANT FLIGHT DIRECTOR																	
OPERATIONS AND PROCEDURES OFFICER																	
LIFE SYSTEMS OFFICER																	
SPACECRAFT COMMUNICATOR																	
CSM EECOM ENGINEER																	
CSM GNC ENGINEER																	
LM EECOM ENGINEER																	
BOOSTER SYSTEMS ENGINEER																	
FLIGHT DYNAMICS OFFICER																	
GUIDANCE OFFICER																	
RETROFIRE OFFICER																	
PUBLIC AFFAIRS OFFICER																	
DOD REPRESENTATIVE																	
LM GNC ENGINEER																	
FLIGHT ACTIVITY AND EXPERIMENTS OFFICER																	
NETWORK CONTROLLER																	
OTHER SYSTEMS** (M&SS, ATM, AM)																	

** PROPOSED

* CROSS HATCH INDICATES
CONSOLE INACTIVE

FIGURE B-5 AAP MISSION HIGH-ACTIVITY
CONSOLE UTILIZATION*

MOCR POSITION	MISSION PHASE	ASCENT TO ORBIT	EARTH ORBIT COAST	TRANSLUNAR INSERTION	TRANSPOSITION DOCKING FINAL SEPARATION	FIRST MIDCOURSE MANEUVER	SECOND MIDCOURSE MANEUVER	LUNAR ORBIT INSERTION AND LM DESCENT	LUNAR STAY	LM ASCENT RENDEZ VOUS AND DOCKING	TRANSEARTH INJECTION	FIRST MIDCOURSE MANEUVER	SECOND MIDCOURSE MANEUVER	REENTRY AND TOUCHDOWN
OPERATIONS DIRECTOR														
FLIGHT DIRECTOR														
OPERATIONS AND PROCEDURES OFFICER														
LIFE SYSTEMS OFFICER														
SPACECRAFT COMMUNICATOR														
CSM EECOM ENGINEER														
CSM GNC ENGINEER														
LM EECOM ENGINEER														
BOOSTER SYSTEMS ENGINEER														
FLIGHT DYNAMICS OFFICER														
GUIDANCE OFFICER														
RETROFIRE OFFICER														
PUBLIC AFFAIRS OFFICER														
DOD REPRESENTATIVE														
LM GNC ENGINEER														
FLIGHT ACTIVITY AND EXPERIMENTS OFFICER														
NETWORK CONTROLLER														
ASSISTANT FLIGHT DIRECTOR														

* CROSS HATCH INDICATES
CONSOLE INACTIVE

TABLE B-6 LUNAR MISSION HIGH-ACTIVITY
CONSOLE UTILIZATION*

The AAP has a requirement to support the systems onboard the M&SS rack, ATM rack, and in the AM, but this is not necessary for a lunar mission. The active periods for these systems during AAP high-activity phases are presented in Table B-5. High-activity periods total 228 hours for lunar missions and 36 hours for the AAP. Based on these figures, the percent utilization of those consoles not used continuously is presented in Table B-7.

TABLE B-7
PERCENT UTILIZATION OF CONSOLES DURING
HIGH ACTIVITY PERIODS

CONSOLE	LUNAR PERCENT USED	OWS PERCENT USED
LM GNC ENGINEER	47	11
LM EECOM ENGINEER	47	11
BOOSTER SYSTEMS ENGINEER	10	81
FLIGHT ACTIVITY AND EXPERIMENTS OFFICER FLIGHT ACTIVITY AND EXPERIMENTS	60	17
OTHER SYSTEMS (M&SS, AM, ATM)		28
DOD REPRESENTATIVE	14	19

APPENDIX C

REMOTE SITE SUPPORT ANALYSIS

C.1 GENERAL

The four major areas presented in this appendix are:

- MSFN support functions required during the OWS time period
- MSFN support capabilities existing and planned for the OWS time period
- Comparison of MSFN support functions and MSFN support capabilities to identify problem areas
- Techniques for optimizing network utilization and resolving problem areas.

This appendix will only summarize the current requirements, lunar mission requirements and ALSEP requirements as these were presented in detail in PHO-TR273. The support functions presented are those primarily unique to the OWS.

The MSFN support capabilities versus the required support functions comparison is made first for the OWS. Then a comparison is made to determine problems associated with simultaneous support of the OWS, a lunar mission, and two ALSEP's. Techniques for optimizing network utilization and resolving problem areas will include:

- Hardware implementation
- Software design
- Operational procedures
- Combinations of the above.

C.2 MSFN OWS SUPPORT FUNCTIONS

C.2.1 Telemetry Processing

The remote site telemetry processor program has the following major functions:

- A. Input Processing. The telemetry processor will be required to accept program changes, output requests, time messages, and vehicle telemetry data. The greatest volume of input type will be the vehicle data. Table C-1 illustrates the types of telemetry input data required and the rates at which the data is input into the program.
- B. Output Processing. The telemetry processor program will output processed, compressed, and formatted telemetry data over two 2.4 kbps data lines to the MCC-H. The formats necessary have not been specified at this time.
- C. Computations. Specific telemetry computations for the OWS have not been stated at this time. It is anticipated that the processing requirements will be similar to the current Apollo requirements. Additional requirements will be necessary for the AM, ATM, and M&SS. Further programming may be required as follows:
 1. GET. Process a GET for each AAP mission.
 2. CTE. Process CTE from each of the AM, ATM and M&SS.
 3. Time Correlation. The AM telemetry data and the CSM telemetry data may require time correlation. A method for accomplishing this may develop into a problem area.

TABLE C-1
TELEMETRY INPUTS

VEHICLE DATA	CSM	LM	AM	ATM	M&SS	S017	SIVB	IU	SII
NORMAL BIT RATE	51.2	51.2	51.2	72.0	NOT TO EXCEED 2.8	1.6	72.0*	72.0*	72.0**
LOW BIT RATE	1.6	1.6	NONE	NONE	NONE	NONE	NONE	NONE	NONE
DUMP OF DATA RECORDED AT NORMAL BIT RATE	51.2	NONE	112.6	72.0	NONE	NONE	NONE	NONE	NONE
DUMP OF DATA RECORDED AT LOW BIT RATE	51.2 OR 1.6	1.6	NONE	NONE	NONE	NONE	NONE	NONE	NONE

*Required only during first 7.5 hours.

**Required during launch phase only.

4. Compression and Formatting. Compression of the vast amount of input telemetry data and formatting this data for output represents a major job for the telemetry processor. This is definitely a problem area and requires the most efficient methods for resolution.

C.2.2 Command Processing

The command processor program will be required to synthesize subbit encode, validate output and verify commands. The vehicles which require commanding are:

- CSM
- LM
- AM
- ATM
- M&SS
- IU/SIVB.

The CSM and LM will be commanded with the USB system. The AM, ATM and SIVB/IU will be commanded via the UHF system. The M&SS will receive commanding via the CSM.

Validation, verification, command loads, real-time commands, and command processing are assumed to be similar to current requirements. The major difference will be the added requirement for support of the AM, ATM and M&SS.

C.2.3 Hardware Support Functions

These functions are required at a remote site in order to:

A. Receive Downlinked Data. The reception of downlinked data is the first and a major function of the remote site. Types of downlinked data include:

- Telemetry
- Voice
- Tracking
- Television
- Engineering
- Voice dump
- Telemetry dump.

The number of downlinks to be supported varies during the time frame of the OWS. For analysis, the OWS has been divided into 18 phases.

Table C-2 presents the uplinks and downlinks associated with the OWS during these phases. Table C-3 depicts the PCM telemetry downlinks.

The scientific subcarriers will use the frequencies 95, 125, and 165 kilocycles for downlinking scientific data.

B. Route Data. Data will be collected and routed by the remote site to these specified destinations.

1. Recorders. All telemetry, voice, engineering, and dump data are recorded.

2. Output to the MCC-H. Voice, tracking data, and biomed data are transmitted to the MCC-H.
3. Perform Required Processing. Telemetry data is fed into the 642B computer which operates with the telemetry data processor. The telemetry processor, as previously described, is required to compress, process, format and output this data over two 2.4 kbps lines to the MCC-H.
4. Uplink Data. The remote site is also required to transmit command loads, real-time commands, voice, and tracking data to the vehicles.

TABLE C-2
OWS DOWNLINKS AND UPLINKS

PHASE NO.	PHASE DESCRIPTION	DOWNLINK						UPLINK				
		USB		VHF		C-BAND	TOTAL	USB	VHF	UHF	C-BAND	TOTAL
		FM	PM	FM	AM			PM	AM	FM		
1	AAP-1* LAUNCH	0	1	4	1	2	8	1	1	1	2	5
2	TRANSPOR- TATION DOCKING	0	1	1	1	2	5	1	1	1	2	5
3	EXTRACTION AND INSERTION	0	1	1	1	2	5**	1	1	1	2	5**
4	FIRST 5 DAYS	1	1	0	1	1	4	1	1	0	1	3
5	AAP-2* LAUNCH	0	1	4	1	2	8**	1	1	1	2	5**
6	RENDEZVOUS DOCKING	1	1	1	1	2	6	1	1	1	2	5
7	AAP-1 AND 2 ORBITAL SUPPORT	1	1	2	2	1	7	1	2	1	1	5
8	ORBITAL EVA SUPPORT	0	1	1	2	1	5	1	2	1	1	5
9	CSM SEPARATION OWS	0	1	0	1	1	3	1	1	0	1	3

*LAUNCH PHASES

**DURING THESE PHASES, THE VEHICLES ARE SEPARATED SO THAT TWO OR MORE REMOTE SITES WILL BE REQUIRED TO RECEIVE ONE OR MORE VEHICLES.

TABLE C-2 (CONT'D)

PHASE NO.	PHASE DESCRIPTION	DOWNLINK						UPLINK				
		USB		VHF		C-BAND	TOTAL	USB	VHF	UHF	C-BAND	TOTAL
		FM	PM	FM	AM			PM	AM	FM		
10	CSM DEORBIT	0	1	0	1	1	3	1	1	0	1	3
11	CM/SM SEPARATION REENTRY	0	1	0	0	1	2	1	0	0	1	2
12	STORED OWS	0	0	1	0	1	2	0	0	1	1	2
13	AAP-3* LAUNCH	0	1	6	1	2	10	1	1	1	2	5
14	AAP-4* LAUNCH	0	1	7	1	2	11**	1	1	2	2	6**
15	CSM/AAP-4 RENDEZVOUS	0	1	2	1	2	6**	1	1	2	2	6**
16	CSM/AAP-2 RENDEZVOUS	0	1	2	1	2	6**	1	1	2	2	6**
17	AAP-2 AAP-3 AAP-4 ORBIT	1	2	4	3	2	12	1	3	1	2	7
18	CSM DEORBIT AND REENTRY	0	1	0	1	1	3	1	1	0	1	3

*LAUNCH PHASES

**DURING THESE PHASES, THE VEHICLES ARE SEPARATED SO THAT TWO OR MORE REMOTE SITES WILL BE REQUIRED TO RECEIVE ONE OR MORE VEHICLES.

TABLE C-3
OWS PCM TELEMETRY DOWNLINKS

PHASE	VEHICLES		CSM	SIVB/ IU	AM	LM	ATM	SIB	TOTAL USB PCM TLM D/L	TOTAL VHF PCM TLM D/L	TOTAL PCM TLM D/L
	SYSTEM										
1*	USB	1						1			3
	VHF		1				1		2		
2	USB	1						1			2
	VHF		1						1		
3	USB	1						1			2**
	VHF		1						1		
4	USB	2						2			2
	VHF								0		
5*	USB	1						1			3**
	VHF		1				1		2		
6	USB	2						2			3
	VHF		1						1		
7	USB	2						2			3
	VHF			1					1		
8	USB	1						1			2
	VHF			1					1		
9	USB	1						1			1
	VHF								0		
10	USB	1						1			1
	VHF								0		
11	USB	1						1			1
	VHF								0		
12	USB							0			1
	VHF			1					1		

*LAUNCH PHASES

**DURING THESE PHASES, THE VEHICLES ARE SEPARATED SO THAT TWO OR MORE
REMOTE SITES WILL BE REQUIRED TO RECEIVE ONE OR MORE VEHICLES.

TABLE C-3 (CONT'D)

VEHICLES		CSM	SIVB/ IU	AM	IM	ATM	SIB	TOTAL USB PCM TLM D/L	TOTAL VHF PCM TLM D/L	TOTAL PCM TLM D/L
PHASE	SYSTEM									
13*	USB	1						1		4
	VHF		2				1		3	
14*	USB	1						1		5**
	VHF		2	1			1		4	
15	USB	1						1		3**
	VHF		1	1					2	
16	USB	1						1		3**
	VHF		1	1					2	
17	USB	2			1			3		5
	VHF			1		1			2	
18	USB	1						1		1
	VHF								0	

*LAUNCH PHASES

**DURING THESE PHASES, THE VEHICLES ARE SEPARATED SO THAT TWO OR MORE REMOTE SITES WILL BE REQUIRED TO RECEIVE ONE OR MORE VEHICLES.

C.2.4 Support Functions for Simultaneous Support of OWS, ALSEP, and Lunar Mission

During the time frame of the OWS, there will be periods when the MSFN will be required to simultaneously support:

- The OWS (all AAP missions)
- A lunar mission (AS-504 or AS-505)
- Two ALSEP's.

The downlinks and uplinks required for ALSEP and lunar mission support are illustrated in Table C-4. The telemetry downlinks are shown in Table C-5.

Two functions required of the MSFN for simultaneous support are:

- Efficient real-time scheduling
- Minimum turnaround time.

TABLE C-4
LUNAR MISSION AND ALSEP DOWNLINKS/UPLINKS

VEHICLE	USB DOWNLINK			USB UPLINK PM
	FM	PM	TOTAL	
LUNAR MISSION	1	2	3	2
ALSEP		2	2	1

TABLE C-5
LUNAR MISSION AND ALSEP TELEMETRY DOWNLINKS

VEHICLE MISSION	CSM	LM	ALSEP NO. 1	ALSEP NO. 2	TOTAL
LUNAR MISSION	2	1			3
ALSEP			1	1	2

- Event Sensing
 - Accept or lock out program changes depending on computer mode
 - Computer GET
 - Perform special processing for certain CSM, SLV, IU, SIVB, and LM parameters.
2. Command Functions. The input and output functions of the command processor program are also given in Table C-7. The processing functions include:
- Restart and reestablish command load information via magnetic tape in the event of computer failure
 - Perform self checks
 - Perform certain clock processing
 - Verify command uplinking
 - Validate HSD and TTY inputs
 - Process commands for uplinking
 - Record data for command history
 - Uplink commands in accordance with the command mode
 - Perform command related functions
 - Detect spacecraft/ground reject
 - Process MCC-H inputs
 - Provide a load inventory.

C.3 PRESENT AND PLANNED MSFN SUPPORT CAPABILITIES

C.3.1 Capability for MSFN to Support OWS

The Final ALSEP Data Management Study Report (PHO-TR273) and the Preliminary Orbital Workshop Data Management Study Report (PHO-TR285) described the MSFN support capabilities in detail as planned for the time period under study. Thus, only a brief summary of these capabilities as they are currently understood will be presented here.

- A. Hardware. After AS-504 all remote sites will be operated in an unmanned mode. Sites will differ only on two major points--antenna size and USB system. The three major groups of remote sites will be:

- 85-foot dual USB sites
- 30-foot dual USB sites
- 30-foot single USB sites.

A capability summary of the remote sites in each of these categories is illustrated in Table C-6.

- B. Software. The software for the OWS, lunar mission, and ALSEP support has not been written at this time. The current remoted site programs may be used in part to develop the new programs that are required. As the current programs are the only ones available at this time, a brief summary of their capabilities follows:

1. Telemetry Functions. The input and output functions of the telemetry processor program are given in Table C-7. The processing functions include:
 - Engineering Unit Conversion
 - Limit Sensing

TABLE C-6
REMOTE SITE CAPABILITIES

SITES	CAPA- BILITY	ANTENNA SIZE	USB		VHF RECEIVERS	HSD LINES	TTY LINES	642B COMPUTERS	PCM		USB UPLINK	UHF UPLINK	ALSEP SUPPORT
			FM	FM					GRND EMR	STA DYN			
85-FOOT DUAL SITES	GDS	85'	2	2	0	6	2	2	0	3	2	0	YES
	MAD	85'	2	2	0	6	2	2	0	3	2	0	YES
	CNB	85'	2	2	0	6	2	2	0	3	2	0	YES
30-FOOT DUAL SITES	MIL	30'	2	2	18	7	2	2	0	3	2	1	YES
	ACN	30'	2	2	12	6	2	2	0	3	2	0	YES
	TAN	30'	2	2	8	6	2	2	0	3	2	0	YES
	CRO	30'	2	2	16	6	2	2	2	1	2	1	YES
	GWM	30'	2	2	16	6	2	2	0	3	2	0	YES
	HAW	30'	2	2	16	6	2	2	2	1	2	1	YES
	GRM	30'	1	1*	6	6	2	2	0	4	1	1	BACKUP
30-FOOT SINGULAR SITES	BDA	30'	1	1*	19	6	2	2	2	2	2	1	YES
	ANG	30'	1	1*	6	6	2	2	0	4	2	1	YES
	CYI	30'	1	1*	16	6	2	2	3	0	1	1	BACKUP
	GYM	30'	1	1*	16	6	2	2	3	0	1	0	YES
	TEX	30'	1	1*	16	6	2	2	2	1	1	1	BACKUP
	VAN	30'	2	2	20	7	2	2 + 1 CDP	0	3	2	1	NO
SHIPS	RED	30'	2	2	12	7	2	2 + 1 CDP	0	3	2	1	NO
	MER	30'	2	2	12	7	2	2 + 1 CDP	0	3	2	1	NO
	HTV**	12'	1	1	12	7	2	1 TLM + 1 CDP	0	2	0	0	NO
	WTN	12'	2	2	12	7	2	1 TLM + 1 CDP	0	2	0	0	NO

*SINGLE SITES HAVE THE CAPABILITY TO SWITCH THIS FM RECEIVER TO PM.

**THIS SHIP MAY BE UPGRADED TO DUAL USB CAPABILITY.

TABLE C-7
SOFTWARE PROGRAM CAPABILITIES

TELEMETRY										
I/O DEVICE FUNCTION	PCM GROUND STATION	GMT	ICC	CAM	I/O CONSOLE	HIGH- SPEED PRINTER	HSD LINES	TTY	WALL CLOCKS	UPDATA BUFFER
VEHICLE DATA	I					O	O	O	O	
GMT		I					O	O		
GMT OF LIFTOFF			I		I	O				
LIMIT CHANGES			I		I	A				
EU CHANGES			I		I	A				
HS FORMAT SELECT			I	I	I	A				
SINGLE OR GROUP PARAMETER				I	I	O				
TTY SUMMARY						O		O		
TTY SUMMARY REQUESTS				I	I	A				
CAP			I				O			
TIME MESSAGE			I							
CMD REQUESTS			O	I						
LEGEND: I - INPUT; O - OUTPUT; A - ACKNOWLEDGE.										

TABLE C-7 (CONT'D)

COMMAND										
I/O DEVICE FUNCTION	PCM GROUND STATION	GMT	ICC	CAM	I/O CONSOLE	HIGH- SPEED PRINTER	HSD LINES	TTY	WALL CLOCKS	UPDATA BUFFER
VEHICLE DATA	I									
CMD LOADS							I	I		O
COMPUTER EXECUTE FUNCTIONS							I	I		
TLM PROCES- SOR DATA LOADS							I	I		
CAP			O					O		
CMD HISTORY						O		O		
CMD HISTORY REQUESTS			I				I			
RTC's										O
CAM REQUESTS			I							
CMD MODE SELECT			I			A	I			
CMD RELATED FUNCTIONS			I			A	I			
EVENTS						A				
ERRORS						A				

LEGEND: I - INPUT; O - OUTPUT; A - ACKNOWLEDGE.

C.4 REMOTE SITE CAPABILITIES VERSUS MULTIMISSION SUPPORT REQUIREMENTS

The following assumptions were made for the comparison of the remote site capabilities with the support requirements.

- A remote site will be required to support OWS, the lunar mission, or the ALSEP's, but not two missions simultaneously
- The 85-foot sites will not be required for OWS support.

This comparison of capabilities with the requirements was made primarily for the OWS. For a more detailed study of lunar mission and ALSEP requirements versus MSFN capabilities, refer to PHO-TR273, Final ALSEP Data Management Study Report.

C.4.1 OWS Support Requirements Versus MSFN Capabilities

C.4.1.1 Hardware Resources

This report considers the OWS mission to be comprised of the following 18 phases.

1. AAP-1 Launch
2. AAP-1 Transposition and Docking
3. Extraction and Separation
4. First 5 Days (AAP-1)
5. AAP-2 Launch
6. AAP-1/AAP-2 Rendezvous and M&SS and CSM Docking
7. AAP-1 and AAP-2 Orbital Support
8. Orbital EVA Support

9. CSM Separation from the OWS
10. CSM Deorbit Burn
11. CSM Separation and CSM Reentry
12. Passivated OWS (3 to 6 Months)
13. AAP-3 Launch
14. AAP-4 Launch
15. CSM/AAP-4 Rendezvous
16. CSM/LM/ATM/AAP-2 Rendezvous
17. AAP-2/AAP-3/AAP-4 Orbit
18. CSM Deorbit Maneuver and Reentry

Launches occur during Phases 1, 5, 13 and 14. They are not considered in this analysis since MIL, GBM, ANG, BDA and the ALDS are considered adequate for supporting the launch phases. These comparisons are made with postlaunch data support requirements. For convenience, the following two phases are used as exemplary phases.

- A. Phase 17 (Maximum Data Load). This is the period of heaviest data load where five vehicles dock together. All five of these vehicles will not downlink simultaneously. Possible downlink combinations are:
 - CSM + AM
 - CSM + AM + S017
 - CSM + AM + ATM + LM

The last combination represents the maximum downlink data load. Therefore, the CSM + AM + ATM + LM combination is used to represent the Phase 17 requirements which are:

- 1 USB/FM downlink
- 2 USB/PM downlinks
- 2 VHF/FM downlinks
- 1 USB/PM uplink
- 1 UHF/FM uplink

B. Phase 7 (Nominal Data Load). The support requirements for Phase 7 follow:

- 1 USB/FM downlink
- 1 USB/PM downlink
- 2 VHF/FM downlinks
- 1 USB/PM uplink
- 2 VHF/AM uplinks
- 1 UHF/FM uplink

Table C-8 is a comparison of the MSFN capabilities with the maximum requirements represented by Phase 17 and the nominal requirements represented by Phase 7. The table also reveals that certain existing or planned site capabilities do not meet the support requirements necessary for the periods of maximum and nominal data loading. Each deficiency is examined and problem areas delineated. The deficiencies indicated by Table C-8 during the maximum load are that:

- GBM, BDA, ANG, CYI, GYM, TEX and HTV are unable to support 1 USB/FM and two USB/PM downlinks simultaneously

TABLE C-8
OWS COMPARISON MATRIX

RESOURCE	OWS DATA LOAD	REQUIRED	SITE CAPABILITY	M I L	A C N	T A N	C R O	G W M	H A W	G B M	B D A	A N G	C Y I	G Y M	T E X	V A N	R E D	M E R	H T V	W T N
USB FM D/L			SITE CAPABILITY	2	2	2	2	2	2	1	1	1	1	1	1	2	2	2	1	2
	MAX.	1	PROBLEM AREA																	
	NOM.	1																		
USB PM D/L			SITE CAPABILITY	2	2	2	2	2	2	1	1	1	1	1	1	2	2	2	1	2
	MAX.	2	PROBLEM AREA																	
	NOM.	1																		
VHF FM D/L			SITE CAPABILITY	18	12	8	16	16	16	6	19	6	16	16	16	20	12	12	12	12
	MAX.	2	PROBLEM AREA																	
	NOM.	2																		
USB PM U/L			SITE CAPABILITY	2	2	2	2	2	2	1	2	2	1	1	1	2	2	2	0	0
	MAX.	1	PROBLEM AREA																	
	NOM.	1																		
UHF U/L			SITE CAPABILITY	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	0	0
	MAX.	1	PROBLEM AREA																	
	NOM.	1																		
PCM GROUND STATION			SITE CAPABILITY	3	3	3	3	3	3	4	4	4	3	3	3	3	3	3	2	2
	MAX.	5	PROBLEM AREA																	
	NOM.	3																		

■ REPRESENTS A PROBLEM AREA OR DEFICIENCY.

- HTV and WTN cannot support the CMD uplink required
- ACN, GWM and GYM have no UHF uplink capability
- None of the remote sites can process five PCM telemetry downlinks simultaneously.

The deficiencies indicated by this table during the nominal load are that:

- HTV and WTN cannot support command requirements
- ACN, GWM and GYM have no UHF uplink capability
- HTV and TWN cannot process three PCM telemetry downlinks simultaneously.

The following two problem areas are not identified in Table C-8:

1. M&SS data downlinked via the CSM over the scientific subcarriers requires real-time processing. At this time, there is no way to process this data in real-time.
2. The S017 experiment which is active during Phase 17 of the OWS is downlinked via USB/FM and requires processing in real-time. This is a unique downlink format that is active during just one phase of the OWS. The hardware is available to input this data into the remote site and route it to the computer. There are no current programs or routines capable of processing this data.

C.4.1.2 Software Resources

The following software comparison is made using the current software capabilities and the 642B computer system

capabilities versus the OWS support requirements. The remote site 642B computer system consists of:

- Two 642B computers at each site
- One 32K core storage per 642B computer
- Two magnetic tapes per 642B computer
- One 2.4 kbps output line to the MCC-H per remote site.

The current telemetry processor program for the unmanned sites uses approximately 80 percent of core storage whereas the command processor program uses 100 percent of core storage. The telemetry processor program also uses one magnetic tape for program storage and loading and the other tape for HSD formats and formatting routines. The command program uses one magnetic tape for program storage and loading and the other for command history storage.

At present the number of HSD output formats varies by mission. For example, there are four required for AS-501, 10 for AS-206, and 14 for AS-258. The format for each vehicle also varies by mission. The capabilities of the 642B computer system to be augmented by the AAP time frame are:

- An additional 16K core storage per 642B computer
- A second 2.4 kbps output line per remote site
- Part time use of a third 2.4 kbps output line per remote site.

Additional programming requirements include:

- Input routines for the AM, S017, scientific sub-carrier data, and ATM downlink data
- Data processing routines for the new vehicles operational data

- Data processing routines for the experiments data
- Output routines for the second and third 2.4 kbps lines
- Output formats for the additional vehicles (AM, SOL7, ATM, scientific subcarrier data, and the experiments data).

C.4.2 Lunar Mission and ALSEP Support Requirements Versus MSFN Capabilities

C.4.2.1 Hardware Resources

Table C-9 is a comparison of the MSFN capabilities by remote site against lunar mission requirements, ALSEP requirements, and combined lunar mission and ALSEP requirements. This table also identifies the following deficiencies:

- A. GBM, BDA, ANG, CYI, GYM, TEX and HTV cannot provide simultaneous support for one USB/FM and two USB/PM downlinks.
- B. GBM, CYI, GYM, TEX, HTV, and WTN cannot provide simultaneous command uplink support for two vehicles.
- C. HTV and WTN cannot support three PCM telemetry downlinks simultaneously.

There are no identifiable deficiencies or problem areas associated with MSFN support of ALSEP. The single USB sites appear to be one USB/PM receiver deficient, but the single USB sites have the capability to receive one FM and one PM or two PM downlinks. Since the ALSEP's will not be using the FM receiver, the two PM receivers can be used and thus satisfy this requirement. The ships lack command capability, but they are not allocated for ALSEP support.

Table C-9 indicates that the remote sites would be unable to simultaneously support the lunar mission and one ALSEP

TABLE C-9

LUNAR MISSION AND ALSEP COMPARISON MATRIX

RESOURCE	MISSION	REQUIRED	SITE	G D S	M A D	C N B	M I L	A C N	T A N	C R O	G U M	H A W	G B M	B D A	A N G	C Y I	G Y M	T E X	V A N	R E D	M E R	H T V	W T N
USB FM D/L			SITE CAPABILITY	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	2	2	2	1	2
	LUNAR MISSION	1	PROBLEM AREAS																				
	ALSEP	0																					
	LUNAR + ALSEP	1																					
USB PM D/L			SITE CAPABILITY	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	2	2	2	1	2
	LUNAR MISSION	2	PROBLEM AREAS																				
	ALSEP	2																					
	LUNAR + ALSEP	4																					
USB PM U/L			SITE CAPABILITY	2	2	2	2	2	2	2	2	2	1	2	2	1	1	1	2	2	2	0	0
	LUNAR MISSION	2	PROBLEM AREAS																				
	ALSEP	1																					
	LUNAR + ALSEP	3																					
PCM GROUND STATION			SITE CAPABILITY	3	3	3	3	3	3	3	3	3	4	4	4	3	3	3	3	3	3	2	2
	LUNAR MISSION	3	PROBLEM AREAS																				
	ALSEP	2																					
	LUNAR + ALSEP	5																					

■ REPRESENTS A PROBLEM AREA OR DEFICIENCY.

during the maximum data load periods of the lunar mission. The remote sites would be unable to meet the following support requirements:

- 4 USB/PM receivers
- 3 USB/PM transmitters
- 5 PCM ground stations.

C.4.2.2 Software Resources

The current Apollo programs for unmanned sites are similar to the programs that will be required for the lunar missions. The programs for the lunar missions and the ALSEP will require:

- Processing for additional transpositions, maneuvers and other phases associated with lunar orbit and lunar landing
- Processing for the ALSEP packages
- Input routines for ALSEP formats
- Output routines for ALSEP formats

It has been stated that the telemetry computer is currently using 80 percent of its core storage and both magnetic tapes. The command computer is using 100 percent of its core and both of its magnetic tapes. By the AAP time frame, each 642B computer will have an additional 16K of core storage per computer and each site will have a second (full time) and third (part time) 2.4 kbps output line.

The following problem areas were identified for the OWS and the lunar mission:

- Core storage
- Number of input and output formats

- Program restart and reinitialization (in case of program fault, computer failure, or power failure)
- Program turnaround from support of one mission to support of another.

C.4.3 MSFN Multimission Support Capabilities Versus Support Requirements

- A. Turnaround Time. A minimum turnaround time of 15 minutes is required for the USB system, decommutators, PCM ground stations, and 642B computers. This time must be reduced in order to provide multimission support. This represents an area that should be given considerable attention in order to effect a timely resolution.
- B. Scheduling. Before the AAP time frame, scheduling was concerned with only one mission at a time, and all sites were available to support the one mission. During the AAP time period, multimissions require complex scheduling support. Prepermission scheduling will continue to be necessary. Real-time scheduling will also be needed because of:
- Real-time resolution of remote site conflicts
 - Rapid remote site turnaround and reconfiguration
 - Proper assignment of MSFN resources in a rapidly changing environment
 - Real-time reconfiguration to support contingencies
 - Need for optimum utilization of network in order to simultaneously support up to six missions.

The implementation of an on-line scheduling system will greatly enhance the network capability for supporting multimissions.

- C. Emergency Downtime and/or Maintenance. The current command processor program has a self-check feature that monitors its operational capability at all times. The telemetry processor program does not have this feature. It would be advantageous for both programs to include this self-check capability to detect program errors as well as computer hardware errors.
- D. GSFC Capabilities Versus Requirements. The GSFC currently has the capability to accept and transmit seven PM and two tracking streams of data to the MCC-H. One 2.4 kbps data line from each of seven remote sites could be received by GSFC. One of two 40.8 kbps lines is used for data transmission from GSFC to the MCC-H while the second 40.8 kbps line is used for overflow. However, the major function of the second line is backup in case of a failure in the first 40.8 kbps line.

Before the AAP time frame, GSFC is to be implemented with either a third 40.8 kbps line or two 230 kbps lines to replace the current 40.8 kbps lines. This will afford NASCOM the capability to route data from any six sites simultaneously. Each site will have the capability of six HSD lines, two of which are 2.4 kbps of PCM telemetry data. During the final cluster configuration (Phase 17), a worst case condition might develop in which five sites would transmit real-time data simultaneously. This would be:

- 3 sites supporting the OWS rendezvous and docking
- 1 site supporting two ALSEP's
- 1 site supporting a lunar mission.

Under this worst case condition, GSFC could throughput the real-time data from these five sites and still have the capability to throughput postpass data from a sixth site.

C.4.4 Summary of MSFN Capabilities Versus OWS, Lunar Mission and ALSEP Requirements

The areas that appear to be deficient in support capabilities for the OWS, the lunar missions, and the ALSEP's are grouped under the following major headings.

- A. Single USBS Site Support. (Refer to Tables C-8 and C-9.) The single USBS sites are not required to support one USB/FM downlink in addition to the two USB/PM downlinks or to uplink to more than one vehicle via USB. Scheduling is planned so that a pass over a single USBS site is also covered by a dual USBS site, thus no real-time data is lost and full commanding is accomplished. Some real-time data, e.g., the CSM dump, can be processed postpass. This would give the single sites the capability to support two PM downlinks.
- B. No UHF Support at ACN, GWM and GYM. (Refer to Tables C-8 and C-9.) ACN, GWM and GYM do not have the capability of UHF uplink. Scheduling of UHF commanding so that other sites are used is necessary, but this does not appear to be a problem.
- C. Reentry Ships Support. (Refer to Tables C-8 and C-9.) Present understanding is that the reentry ships are instrumented to capacity so that further implementation is physically impossible. The reentry ships are not required to have full USBS capability or full command and telemetry capability. This deficiency is not a problem area for AAP support.
- D. PCM Ground Station Support During Phase 17 of the OWS. (Refer to Tables C-8 and C-9.) During Phase 17, the OWS multivehicle cluster causes a non-nominal burden on the MSFN. Five downlinks (CSM, CSM dump, AM, ATM, and LM) require simultaneous support. A combination of any two of the following suggestions can be used as a solution:
 - 1. Implement another PCM ground station at each of the 15 remote sites.

2. Constrain operational procedures to prevent the problem from occurring.
3. Time-share the processing of the ATM and AM down-links.
4. Process CSM dump data postpass.

Items 3 and 4 above are recommended because of:

- Less cost
- Non-affected operational procedures
- Simplified processing.

- E. Remote Site Computer Programs. These programs are greatly affected by the multimission, multivehicle atmosphere of the OWS time period. Standardization of programs and formats appears to be necessary (refer to Subsection C.5). A recommended remote site program design is discussed in Subsection 4.2 of this report.
- F. Remote Site Turnaround. The 15-minute turnaround time currently necessary must be reduced. This appears to be a problem area because of its part in remote site scheduling. Techniques for reducing this turnaround time are discussed in Subsection C.5 of this Appendix.
- G. Real-Time Processing of the Scientific Subcarriers. This requirement cannot be supported by current capabilities at the remote sites. The following steps are therefore necessary to satisfy this requirement:
1. The USB system must be implemented with additional demodulators.
 2. Additional equipment is required to interface between the USB system and the PCM ground stations.

3. The PCM ground stations will be required to incorporate the downlink formats associated with these subcarriers.
4. The RSDP programs will require additional input routines, data handling routines, data processing routines, and output formats for this data.
5. Operational procedures will require implementation to provide for site turnaround including hardware and software setup.

H. Real-Time Processing of the S017 Downlink. The requirement for real-time processing of S017 experiment downlink imposes a hardship on the PCM ground station and the telemetry processor program. This requirement results in the following:

1. The PCM ground station must be set up by programming or patchboard to receive this unique downlink format.
2. Special routines for input and data handling must be prepared for the remote site programs.
3. Attitude data from the CSM is necessary for processing this data, thus causing more complicated programming.
4. A special output format is necessary to transmit this data to the MCC-H. This format must be available either in core or on tape although it is used during only one phase of the OWS.
5. Additional operational procedures are necessary to turn the site around to receive and process this downlink which is active for only 3 days during the OWS.

The problems of handling S017 data could be simplified by downlinking this data in another vehicle's format. This would eliminate the necessity for unique input

formats in the PCM ground station and the telemetry processor program and the one of a kind output format in the telemetry processor program. Data processing and handling could be accomplished with subroutines. Operational procedures would also be simplified because special remote site setup procedures would be limited to telemetry processor program inputs.

C.5 TECHNIQUES FOR OPTIMIZING NETWORK UTILIZATION

A review of the previously discussed areas suggests several techniques which could optimize the utilization of the network. The major element of these techniques is standardization which is increasingly necessary for the MSFN to be responsible for multi-mission and multivehicle support for longer time periods and for greater activity periods.

C.5.1 Standardization of Space/Ground Data Formats

Multimission and multivehicle support impose major problems on the remote sites. Each vehicle with its unique format must be programmed into the new Dynatronic PCM ground stations or patched up for the EMR PCM ground stations. The telemetry processor program must have input routines for each format. During the OWS time frame, approximately 15 different vehicles and 29 different formats will require processing.

It is recommended that the downlink formats be standardized. This would simplify the support functions of the PCM ground stations and the RSDP programs. The following is one suggested set of three standard formats:

- 51.2 kbps data
- 1.6 kbps data
- 72.0 kbps data.

Each format is divided into the following five sections.

- Sync words
- Housekeeping data
- Time words
- Operational data
- Operational/Experiments data.

The operational data area could be further divided into areas by the type of processing required, i.e., limit sensing, event sensing, and special processing. The last area could be used for experiments data if required. If experiments data is not required, this area could be used for additional operational data provided similar processing is required.

The major advantage of standardization to the PCM ground stations would be the great reduction in the number of formats. Three formats could easily be stored in the memory of the Dynatronic stations, and the EMR stations would need only three patchboards.

The impact that standard downlink formats would have on the RSDP program is another advantage. Reductions could be made in the number of input routines and the number of input formats. This would result in savings in core storage, programming efforts, program modification, and program checkout. Special processing and experiments data could be handled by subroutines stored on magnetic tape and read into the core during the needed periods.

C.5.2 Increased Stripping Functions by the PCM Decommutators

The decommutators currently act as a buffering system for the telemetry data before it is fed into the computers. They have the capability to strip out parameters and transfer these to the computer. At present, parameter selection is done by the computer programs. The entire downlink format is input into the computer, and the parameters to be processed and transmitted to the MCC-H are selected and stored in a telemetry user's table. From this table the parameters are processed as required and moved to the output tables.

If the decommutators could perform the parameter selection functions, a great deal of core storage and programming could be saved. There are two tables for each input in addition to the routines necessary for selecting the parameters and moving them to the user's table. Data inputs are broken down as follows.

A. CSM

- 128 words = 1 input frame

- 50 frames = 1 second of data
- $128 \times 50 = 6400$ words per second
- $6400 \text{ words} \times 8 \text{ bits per word} = 51.2 \text{ kbps}$

B. SIVB/IU

- 60 words = 1 input frame
- 30 frames = 1 master frame
- 4 master frames = 1 master master frame
- 120 frames = 1 second of data
- $120 \times 60 = 7200$ words per second
- $7200 \text{ words} \times 10 \text{ bits per word} = 72.0 \text{ kbps}$

Approximately 7000 core locations are used by the current telemetry input processors (TIP) routines which perform input, parameter selection, housekeeping, and parameter transfer to user's table functions. About 35 percent of these routines are necessary to perform the functions which could be done by the decommutators.

Core savings during a nominal operation of two 51.2 kbps and one 72.0 kbps input streams could be estimated as follows:

128 words	= 1 frame of first 51.2 kbps input
128 words	= 1 frame of second 51.2 kbps input
<u>60 words</u>	= 1 frame of 72.0 kbps input
316 words	= Total
<u>x2 blocks</u>	per input frame
632 words	= savings in input tables
<u>2450 words</u>	= 35 percent of 7000 words TIP
3082 words	= total estimated core savings

C.5.3 Standardized MSFN to MCC-H Data Formats

The meaning of Formats must be clearly defined and agreed upon before any standardization is possible. First to be defined must be an output table which is a block of data made up of a specific number of words, each having a specific number of bits. An output table could also be called a matrix of data. A format is the specific order of data in a table or the procedure used to fill a table or matrix with data. For example:

1	A
2	E
3	I
4	C
5	K
6	J
7	F
8	B
9	L
10	G
11	M
12	N
13	D
14	H

Example 1

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	21
22	23	24

Example 2

	1	2	3
A	B	C	
4	5	6	
D	E	F	
7	8	9	
G	H	I	
10	11	12	
J	K	L	
13	14	15	
M	N		
16	17	18	
19	20	21	
22	23	24	

Example 3

Example 1 is a table filled with data and Example 2 is a table or matrix to be filled with data from Example 1. The order or procedure stating which parameter in Example 1 should be moved to a specific slot in Example 2 is called formatting and results in Example 3. The format of Example 3 is the order or arrangement of data in the example. The major problems concerning formats being experienced by the MSFN are that:

- A vehicle (e.g., CSM) format changes from mission to mission
- The number of formats varies from mission to mission
- The combinations of vehicles vary from mission to mission.

The AAP time frame presents the problems of multivehicles, short turnaround times between vehicle launches, programming constraints, and checkout constraints. It would be of great advantage to the MSFN if each vehicle downlinked the same parameters in identical formats. The remote site could then have one output table with one output format. Only an identification word would be necessary to identify the vehicle and, unfortunately, this is not feasible.

Any format standardization would be influenced by the following factors:

- 8 basic types of vehicles will require data handling
- At least two and sometimes three 2.4 lines will be used to transmit data from each remote site to the MCC-H
- Versatility
- Standardization of vehicle(s) format regardless of mission.

The three suggested solutions are described in Tables C-10, C-11, and C-12.

TABLE C-10
SOLUTION A, 7.2 KBPS STANDARD FORMATS

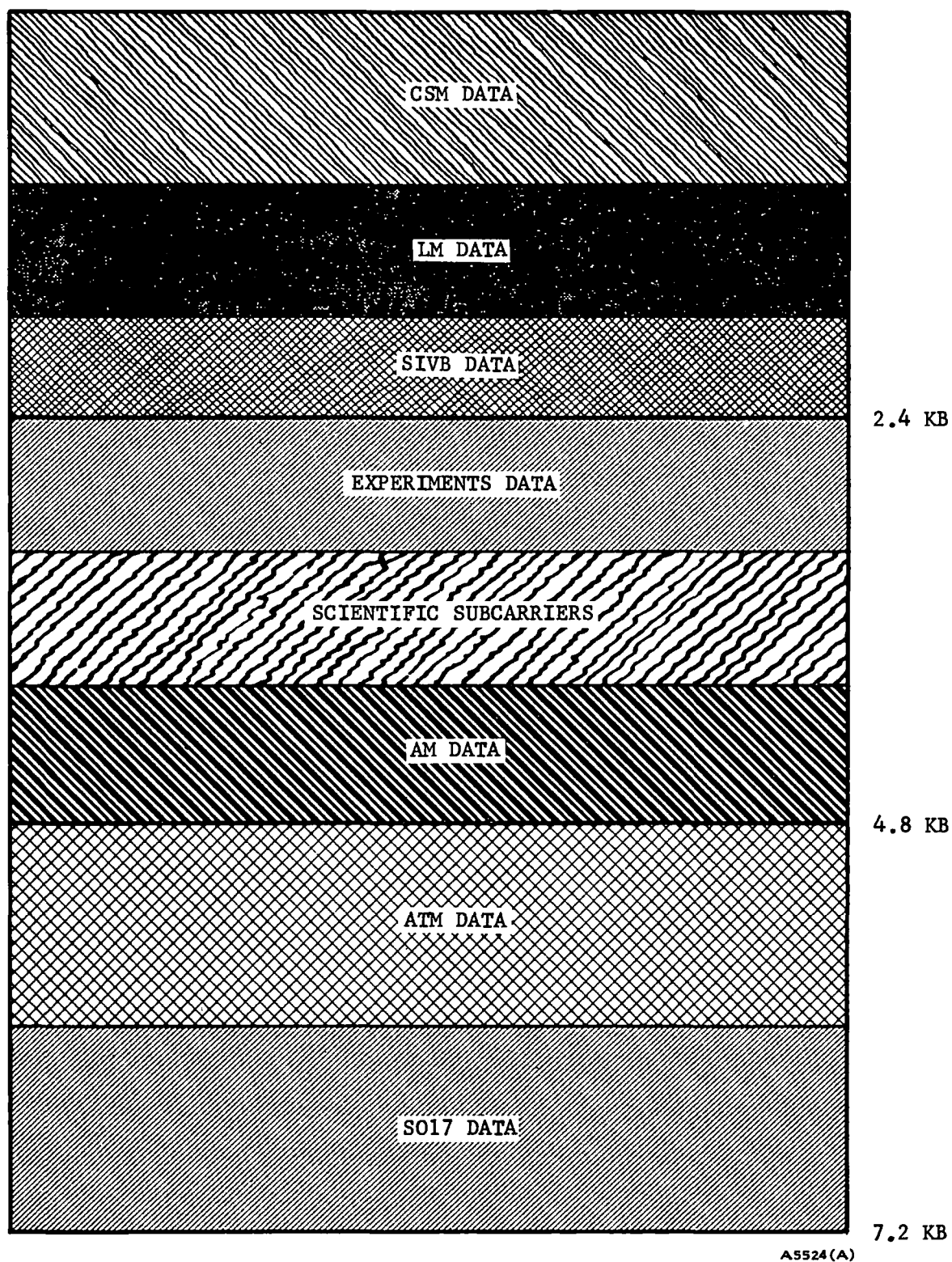


TABLE C-11
SOLUTION B, STANDARD 300-WORD FORMATS

FORMAT NO.	VEHICLE	TYPE DATA	COMMENTS
1	CSM	OPERATIONAL DATA	THIS FORMAT IS USED FOR LIVE OR DUMP, HIGH OR LOW BIT RATE DATA
2	LM	OPERATIONAL DATA	
3	SIVB/IU	OPERATIONAL DATA	
4	AM	OPERATIONAL DATA	
5	ATM	OPERATIONAL DATA	
6	SO17	EXPERIMENTS DATA	
7	SCIENTIFIC SUBCARRIER	EXPERIMENTS DATA	
8	EXPERIMENTS DATA	EXPERIMENTS DATA	
9	ALSEP	OPERATIONAL AND EXPERIMENTS DATA	

NOTE: EACH FORMAT IS COMPOSED OF 300 WORDS OR 2400 BITS.

TABLE C-12
SOLUTION C, STANDARD OUTPUT FORMATS

FORMAT NO.	VEHICLE	TYPE DATA	COMMENTS
1	CSM	OPERATIONAL	THIS FORMAT CAN BE USED BY LIVE OR DUMP AND BY HIGH OR LOW BIT RATE DATA
2	CSM	OPERATIONAL PLUS EXPERIMENTS	THIS FORMAT CAN BE USED BY LIVE OR DUMP AND BY HIGH OR LOW BIT RATE DATA
3	SIVB/IU	OPERATIONAL	
4	SIVB/IU	OPERATIONAL PLUS EXPERIMENTS	
5	AM	OPERATIONAL	
6	AM	OPERATIONAL PLUS EXPERIMENTS	
7	ATM	OPERATIONAL	
8	ATM	OPERATIONAL PLUS EXPERIMENTS	
9	LM	OPERATIONAL	
10	LM	OPERATIONAL PLUS EXPERIMENTS	
11	SO17	EXPERIMENTS	
12	SCIENTIFIC SUBCARRIER	EXPERIMENTS	
13	ALSEP	NORMAL	THIS FORMAT CAN BE USED FOR THE 1.06 Kbps DATA RATE
14	ALSEP	HIGH BIT RATE	THIS FORMAT CAN BE USED FOR THE 10.6 Kbps DATA RATE

NOTE: EACH FORMAT IS COMPOSED OF 150 WORDS OR 1200 BITS.

- A. Solution A. This consists of two basic formats, but the ALSEP format is not shown. Table C-10 illustrates an output format that can be used during the OWS or the lunar mission. A specific number of words are designated for each vehicle. If that vehicle is inactive, its designated slots are "fill data." During periods when CSM + LM, CSM + SIVB/IU, LM + SIVB/IU, or CSM + LM + SIVB/IU data is required, the first 2.4 kilobits of data could be transmitted. During a phase when experiments data, scientific subcarrier data, and/or AM data is required, 4.8 kilobits of the format could be transmitted. During Phase 17 of the OWS, all 7.2 kilobits of data would be required although some vehicle slots would be "fill data." This solution offers the most simple and most standardized method, but it has the following disadvantages:
- Minimum versatility
 - Space is idle when vehicles are inactive.
- B. Solution B. This solution offers more versatility and is the recommended method. Each vehicle has a standard 2.4 kilobit format. By selection, a site can output over one, two, or three 2.4 kbps lines. Each output line would contain data from only one vehicle. During the lunar mission, the output would be one of three configurations as seen in Table C-13. During the OWS there are many combinations. The combinations necessary for Phases 1, 7, and 17 are illustrated in Table C-14.
- C. Solution C. Solution C offers the most versatility of the three but it has the disadvantage of having the greatest number of formats (refer to Table C-12). Each block of data is made up of 150 words or 1200 bits. Thus each format takes up half of a 2.4 kbps output line. The example combinations of these formats during the three phases of the lunar mission and the OWS are given in Tables C-15 and C-16 respectively.

TABLE C-13
SOLUTION B, FORMAT COMBINATIONS FOR LUNAR MISSION

LUNAR PHASE DESCRIPTION	2.4 KBPS OUTPUT LINE NUMBER	FORMAT NUMBER	DESCRIPTION
CSM ACTIVE AND DUMPING (LM ACTIVE)	1	1	CSM LIVE DATA
	2	1	CSM DUMP DATA
	3	2	LM LIVE DATA
CSM ACTIVE BUT NOT DUMPING (LM ACTIVE) (EXPERIMENTS ACTIVE)	1	1	CSM LIVE DATA
	2	2	LM DATA
	3	8	EXPERIMENTS DATA
CSM BEHIND MOON (LM ACTIVE)	1	2	LM DATA
	2	NONE	LINE INACTIVE
	3	NONE	LINE INACTIVE

TABLE C-14
SOLUTION B, FORMAT COMBINATIONS FOR OWS

OWS PHASE NUMBER	2.4 KBPS OUTPUT LINE NUMBER	FORMAT NUMBER	DESCRIPTION
1	1	1	CSM LIVE DATA
	2	3	SIVB/IU DATA
	3	NONE	LINE INACTIVE
7	1	1	CSM LIVE DATA
	2	1	CSM DUMP DATA
	3	4	AM DATA
17	1	1	CSM LIVE DATA
	2	2	LM DATA
	3	4 OR 5	THIS LINE ALTERNATES BETWEEN AM AND ATM DATA DEPENDING ON VEHICLE ACTIVITY

TABLE C-15
SOLUTION C, FORMAT COMBINATIONS FOR LUNAR MISSION

LUNAR PHASE DESCRIPTION	2.4 KBPS OUTPUT LINE NUMBER	FORMAT NUMBER	DESCRIPTION
CSM ACTIVE AND DUMPING (LM ACTIVE)	1	1 + 2	CSM HIGH ACTIVITY COULD REQUIRE MORE OPERATIONAL PARAM- ETERS
	2	1 + 9	CSM DUMP DATA LM DATA
	3	NONE	LINE INACTIVE BUT COULD BE USED FOR NO. 10 IF EXTRA LM PARAMETERS ARE REQUIRED
CSM ACTIVE BUT NOT DUMPING (LM ACTIVE) (EXPERIMENTS ACTIVE)	1	1 + 2	CSM LIVE AND EXPERIMENTS DATA
	2	9 + 10	LM OPERATIONAL AND EXPERIMENTS DATA
	3	NONE	LINE IS INACTIVE
CSM BEHIND MOON (LM ACTIVE)	1	9 + 10	LM OPERATIONAL AND EXPERIMENTS DATA
	2	NONE	LINE IS INACTIVE
	3	NONE	LINE IS INACTIVE

TABLE C-16
SOLUTION C, FORMAT COMBINATIONS FOR OWS

OWS PHASE NUMBER	2.4 KBPS OUTPUT LINE NUMBER	FORMAT NUMBER	DESCRIPTION
1	1	1 + 2	CSM LIVE OPERATIONAL DATA AND CSM EXPERI- MENTS DATA
	2	3 + 4	SIVB/IU OPERATIONAL DATA
	3	NONE	LINE INACTIVE
7	1	1 + 2	CSM OPERATIONAL AND EXPERIMENTS DATA
	2	1 + 5	CSM DUMP AND AM OPERATIONAL DATA
	3	NONE	LINE IS INACTIVE BUT COULD BE AVAILABLE FOR No. 6 ADDITIONAL AM PARAMETERS
17	1	1 + 9	CSM OPERATIONAL AND LM OPERATIONAL
	2	5 + 6 OR 7 + 8	AM OR ATM OPERATIONAL AND EXPERIMENTS ALTER- NATE BETWEEN THESE DE- PENDENT UPON VEHICLE ACTIVITY
	3	NONE	LINE IS INACTIVE BUT COULD BE USED FOR NO. 2 OR NO. 10 IF CSM OR LM REQUIRED ADDITIONAL PARAMETERS

C.5.4 Remote Site Turnaround

Remote site turnaround time, currently estimated at 15 minutes, is required for equipment as well as software turnaround. The major factor in the hardware turnaround time is the retuning necessary for switching frequencies while the console and display setup at currently manned sites is a major factor in software turnaround. The latter will not be a factor during AAP as all sites will be unmanned. The following procedures could reduce the site turnaround time.

- A. Use magnetic tapes exclusively to input programs and formats into the computer.
- B. Design remote site programs so that initialization is automatic.
- C. Standardize space/ground data formats to simplify turnaround functions of the USBS, PCM ground stations, and telemetry processor programs.
- D. Standardize output formats so that format selection can be simplified.
- E. Automate the configuration of remote site resources.
- F. Set up on-line scheduling of remote site resources by the MCC-H.

APPENDIX D
ANALYSIS OF ONBOARD
DATA MANAGEMENT SYSTEMS

D.1 GENERAL

D.1.1 Purpose of Analysis

The cluster configuration of the OWS represents the largest single source of data requiring support from the remote sites. The configuration consists of four types of data management systems, each with its own format and RF downlink. This combination of systems requires analysis not only during the final cluster arrangement, but also during the independent missions and mission phases leading to the cluster arrangement.

D.1.2 Analysis Approach

This analysis will investigate methods of exploiting the AM telemetry system to reduce the processing requirements for the remote sites. The operational conditions will be examined to determine peak loading conditions from the cluster configuration. Various techniques will then be explored to take full advantage of the AM telemetry capability. The major emphasis will be placed on the experiments which have independent data systems and data downlinks. The other experiments associated with the OWS have very low data rates and few real-time support requirements.

D.1.3 Analysis

The remote site support requirements will be established by examining the RF data downlinks and the data management systems from each vehicle for each mission phase. The data capability of the AM telemetry will be evaluated with emphasis on the biomedical data rates. Alternate methods to reduce the number of downlinks requiring remote site support will be presented.

D.2 RF DOWNLINK SUMMARY

The downlink requirements vary with each mission and mission phase. Therefore, each mission and system is discussed separately, and then the total required support is summarized.

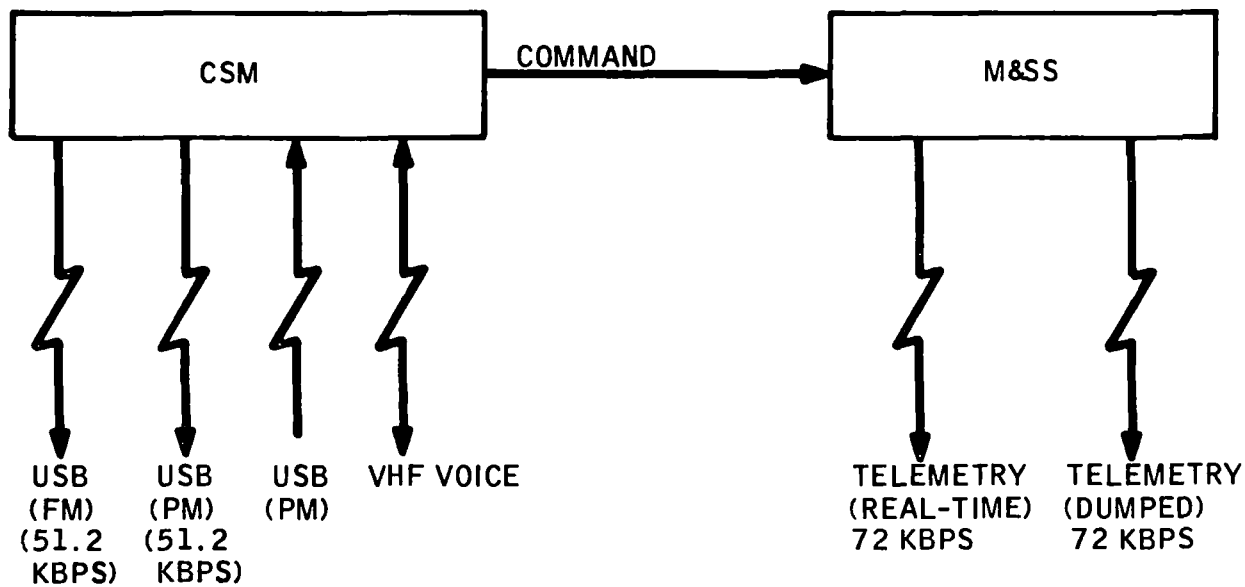
D.2.1 AAP-1 Mission

The docked CSM/M&SS will perform M&SS experiments during the first five days of this mission. It is anticipated that the M&SS data will be downlinked through the CSM scientific subcarriers. Three methods of downlinking the data have been proposed and these methods and their ground support requirements are discussed below.

- A. Proposed Independent M&SS Data Management and Downlink. The M&SS data is downlinked by an independent VHF (PCM) downlink for the real-time support functions. An on-board recorder may be required for dumping recorded experiments functions, and command to the M&SS is processed through the USB (PM) uplink of the CSM. (Refer to Figure D-1.) The CSM downlinks real-time operational data through the USB (PM) downlinks. The recorded CSM operational data is dumped through the USB (FM) downlink, and voice is supported via USB (PM) and/or the VHF downlink of the CSM.

The operational data (attitude and inertial) is important to the experiment. The M&SS system would have an independent time reference generator which functions to provide a time reference to the camera systems and to the data management system. A method may be required for correlating the experiment time (M&SS) with the operational time (CSM). Such a technique may presently exist within the systems.

This proposed data management system for the M&SS exhibits the characteristics of the astronics IU system. The output of this system is a 72 kilobit data stream. The experiment data requirements do not absorb much of



NOTES:

- (1) COMMAND TO M&SS THROUGH CSM COMMAND SYSTEM.
- (2) DUMPED TELEMETRY OF M&SS BY GROUND COMMAND (IF REQUIRED).
- (3) ATTITUDE AND INERTIAL POSITION PARAMETERS DOWNLINKED THROUGH USB (PCM) OF CSM.
- (4) EXPERIMENT S017 CARRIED ON M&SS RACK

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FIGURE D-1 PROPOSED METHOD TO DOWNLINK M&SS DATA

this data capability even if all experiment parameters are downlinked simultaneously and most of the 72 kbps will be fill data. (Refer to Table D-1 for the ground support required for this configuration.)

TABLE D-1
M&SS SUPPORT DURING AAP-1
USING INDEPENDENT DOWNLINK

SYSTEM	DOWNLINKS		PCM GROUND STATIONS	
	REAL-TIME	DUMPED	REAL-TIME	POSTPASS
M&SS	VHF (PCM) (72 KBPS)	VHF (72 KBPS)	1	1*
CSM	USB (PM) (51.2 KBPS)	USB (FM) (51.2 KBPS)	1	1
	VHF (VOICE)			

*The requirement for record and dump capability is not defined.

- B. M&SS Data Downlinked Through the CSM. The data rate of the M&SS is such that two possibilities exist for downlinking the data through the CSM:

1. First Method. The existing capability of the CSM data management system is adequate in space and parameter sampling rates to process the M&SS parameters. Accomplishing a direct integration of the M&SS telemetry requirements into the CSM 51.2 kbps telemetry downlink would require hardwiring each parameter from the M&SS to the CSM through a physical and electrical interface. The number of hard wires necessary for making this interface may be reduced to a signal path and sync circuits by

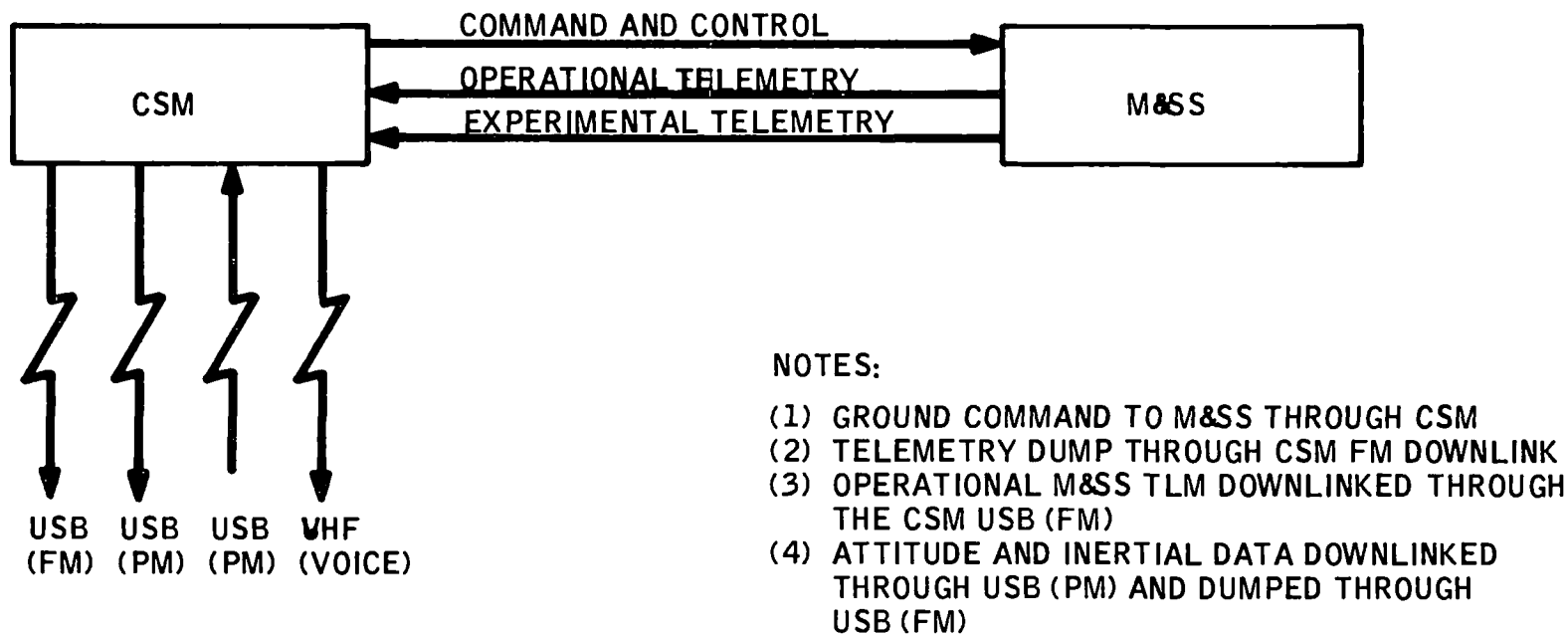
providing a CSM type submultiplexer that would interface the M&SS data to the CSM telemetry system. Although this method is feasible, it requires some modification to the CSM telemetry system wiring which could preclude its use.

2. Second Method. The lunar version of the M&SS will downlink the M&SS data through the scientific subcarriers of the USB (FM) downlink. The existing data rate does not appear to exceed the modulation capability of the scientific subcarriers. The dump requirement for this data is met by the record capability of the analog channels of the CSM onboard recorder. When the dump mode of the scientific subcarriers is examined, the dump capability of the subcarriers is not sufficient to handle a data dump rate at the 32:1 dump ratio. It is necessary, therefore, to dump the data at a 1:1 ratio. Special demodulators for the scientific subcarriers are required at the remote sites to demodulate the scientific subcarriers. An interface to the remote site data systems will also be necessary for real-time and postpass processing. This method appears to be the most feasible approach to downlink the M&SS data for the following reasons:

- One software routine for the 72 kbps is eliminated
- The lunar version of the M&SS is more accurately simulated in the data processing area
- All data is downlinked through the USBS
- The system can be more efficiently integrated into the AM during the cluster configuration.

D.2.2 AAP-2 Mission

The AAP-2 mission is launched approximately 5 days after the AAP-1 launch. This mission will insert the OWS/AM/MDA into the desired orbital parameters. The CSM/M&SS will actively rendezvous with the OWS/AM/MDA although the M&SS is inactive during



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FIGURE D-2 ALTERNATE METHOD TO DOWNLINK M&SS DATA
(THROUGH CSM)

this period. The orbiting vehicles downlink capability and ground station support summary is given in Table D-2. As can be seen from this table, the remote sites have the capability to simultaneously support AAP-1 and AAP-2. The housekeeping requirements for the AM consist of 4036 bps (excluding biomedical requirements). Such a low bit rate could easily be handled by the CSM telemetry system, either by direct integration or by using the scientific subcarriers. The experiments associated with the orbital workshop are not presently defined as having real-time support requirements and their data rates are such that they could be integrated into the CSM data stream or onto the scientific subcarriers. This does not imply that an onboard data management system is not required for the AM, but it does suggest that the interface capability exists after the CSM docks with the cluster. Such an arrangement would place all real-time support functions into one RF downlink since none of the experiments require real-time support nor could any of them serve as a back-up situation should the AM RF downlink fail.

TABLE D-2
AAP-1 AND AAP-2 DOWNLINK SUPPORT SUMMARY

VEHICLE	DOWNLINKS		PCM GROUND STATIONS	
	REAL-TIME	DUMPED	REAL-TIME	POSTPASS
CSM	USB (PM) (51.2 KBPS)	USB (FM) (51.2 KBPS)	1	1
AM	VHF (51.2 KBPS)	VHF (112.6 KBPS)	1	1

Although this approach is feasible, the AM system requires data management because of the other AAP missions. This approach will be discussed in detail later in the analysis. Command functions are required by the AM. These functions are uplinked by UHF ground systems and are processed by the onboard Gemini type command system of the AM. Command verification is routed through the AM telemetry system to the remote site.

D.2.3 AAP-3 Missions

The payload of the AAP-3 mission is a manned CSM and is possibly a resupply module. If the resupply module is a part of this mission, some telemetry support will be required to evaluate its status. At present, the RM is not a valid requirement. If it should become a requirement, two techniques can be explored for downlinking any required telemetry data. The CSM PCM telemetry capability or its scientific subcarriers could be used, or an independent data management system with an associated downlink could be employed. The AM has an operational downlink which requires support during this period. Table D-3 summarizes the proposed downlinks and ground support requirements for the AAP-3 and AAP-2 time interval. Table D-3 also demonstrates that the remote site is fully utilized to support the AAP-2 and AAP-3 mission during these mission phases, should a resupply module become a requirement.

TABLE D-3
AAP-2 AND AAP-3 DOWNLINK SUPPORT SUMMARY

VEHICLE	DOWNLINKS		PCM GROUND STATIONS	
	REAL-TIME	POSTPASS	REAL-TIME	POSTPASS
CSM	USB (FM) (51.2 KBPS)	USB (FM) (51.2 KBPS)	1	1
AM	VHF (72 KBPS)	VHF (112.6 KBPS)	1	1
RM*	VHF (UNKNOWN)		1	

*Requirement not defined.

D.2.4 AAP-4 Mission

The orbiting vehicles for AAP-4, which is launched approximately 1 day after AAP-3, are the LM and ATM. The CSM rendezvous, docks, and extracts the LM/ATM from the launch vehicle. It has not been defined if the LM/ATM will have active downlinks during the rendezvous and docking phase. Such a requirement for real-time support would exceed the capability of the remote sites (refer to Table D-4). Table D-4 demonstrates that the active LM/ATM downlinks during rendezvous and docking sequence would exceed the remote site PCM ground station capability (3 PCM ground stations). For the purposes of this analysis, it is assumed that the LM/ATM are not required to downlink data during this mission phase.

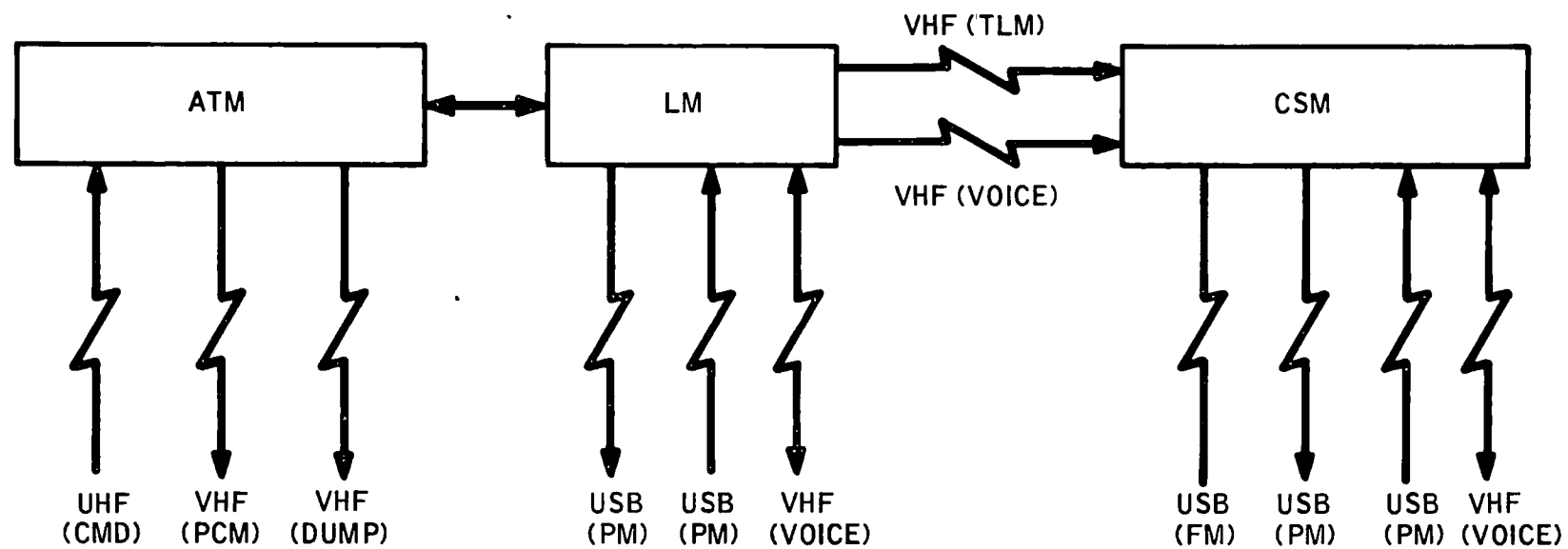
TABLE D-4
DOWNLINK SUPPORT WITH ACTIVE LM/ATM DURING RENDEZVOUS

VEHICLE	DOWNLINKS		PCM GROUND STATIONS	
	REAL-TIME	POSTPASS	REAL-TIME	POSTPASS
SIVB/IU	VHF (72)		2	
CSM	USB (51.2)	USB (51.2)	1	1*
LM	USB (51.2)		1	
ATM	VHF (72)	VHF (72)*	1	1*
TOTAL			5	2*

*A data dump requirement would not normally exist during this phase.

The design specifications for the LM/ATM require that the ATM experiments be performed in the following operational modes.

- LM/ATM docked to the OWS



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FIGURE D-3 ATM DATA DOWNLINKS
(ALTERNATE METHODS)

- LM/ATM docked to the CSM
- LM/ATM in a free flying mode
- LM/ATM in a tethered mode.

Modes 3 and 4 are special cases of modes 1 and 2. Modes 3 and 4 present the same number of downlinks to be supported as modes 1 or 2, but they are presented under slightly different operational conditions. The telemetry downlinks and ground support necessary for the LM/ATM docked to the CSM are given in Table D-5. Figure D-3 shows the total ground support requirement.

A bit count of the total telemetry requirement of the ATM reflects that the ATM telemetry cannot be integrated into either the CSM or LM telemetry system, but it must be processed by an independent downlink for the CSM/LM/ATM mode.

TABLE D-5
DATA DOWNLINKS AND GROUND SUPPORT FOR LM/ATM
DOCKED TO CSM

OPN MODE	VEHICLE	DATA DOWNLINKS		PCM GROUND STATIONS	
		REAL-TIME	DUMPED	REAL-TIME	POSTPASS
LM/ATM	CSM	USB (51.2)	USB (51.2)	1	1
DOCKED TO CSM	LM	USB (51.2)		1	
	ATM	VHF (72)	VHF (72)	1	1

Under normal mission conditions, the CSM docks the LM/ATM to the orbital workshop. At this time the OWS configuration will consist of the OWS/M&SS/CSM/LM/ATM. This clustered configuration presents the worst case condition for ground support.

D-12

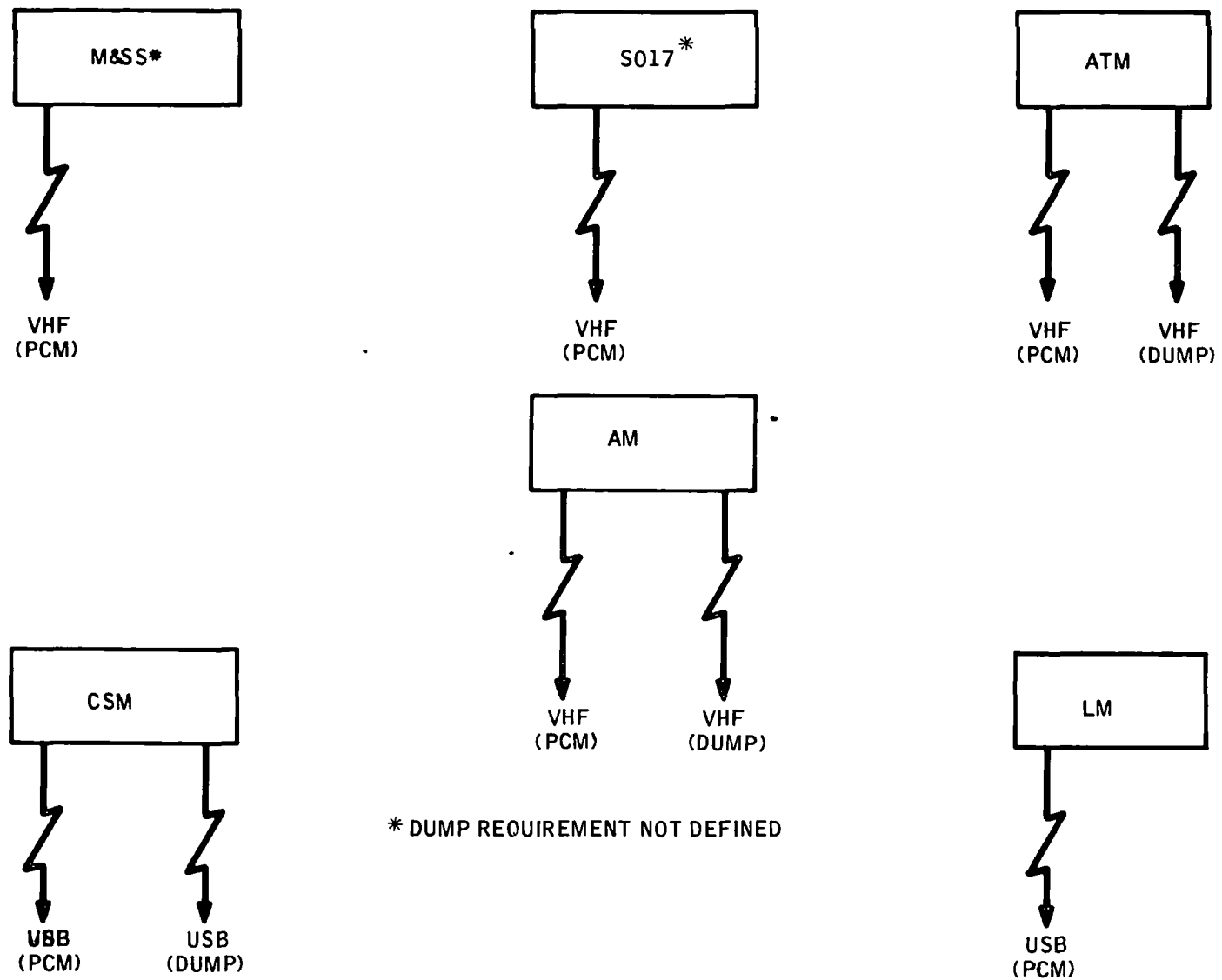


FIGURE D-4 RF DOWNLINKS FOR INDEPENDENT EXPERIMENTS
SYSTEMS CLUSTER CONFIGURATION

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D.2.5 Cluster Configuration

The cluster configuration presents a special support function to the ground systems. This configuration is analyzed against the following operational assumptions:

- A. The CSM will be manned by a minimum of one crew member at all times. The CSM PCM downlink requires real-time support during all ground support periods.
- B. The AM will serve as the center of experiments activities and its telemetry downlink will be supported during all support periods when the OWS is manned and during experiments activities and EVA's associated with the AM.
- C. Two crew members will be required to perform all experiments which are conducted external to the CSM.
- D. ATM, M&SS and X-ray Astronomy (S017) will be performed during separate time intervals in the mission timeline.
- E. The LM operational downlink will require real-time operational support during any manned period and during the ATM experiments.

Figure D-4 presents the total downlink capability of the cluster configuration. The use of the downlinks is restricted by the experiment sequence and crew participation in these experiments. It is established in Table D-6 that the critical support condition exists during the ATM experiments. The real-time situation requires special consideration for this support period.

Table D-6 outlines the support combinations that exist during the cluster configuration when the various downlinks are involved. It also presents the worst case loading of the remote sites during the AAP-4 mission. The remote site processing of real-time telemetry downlinks is limited by the three PCM decommutation ground stations at each site. The remote site PCM ground stations will be fully utilized with three real-time downlinks during the M&SS and X-ray Astronomy experiments. The four downlinks to be processed during the ATM experiments exceed the

capability of the remote sites except GBM, BDA and ANT. During this experiment, one crew member is in the ATM area, one crew member is in the LM, and one crew member is in the CSM.

TABLE D-6
CLUSTER CONFIGURATION DOWNLINKS

EXPERIMENT	DOWNLINKS REQUIRING SUPPORT						
	CSM	AM	M&SS	SO17	ATM	LM	TOTAL
OWS EXPERIMENTS	X	X					2
M&SS	X	X	X				3
SO17	X	X		X			3
ATM	X	X			X	X	4

Because these vehicles are manned, the LM and CSM present a mandatory real-time support requirement. The AM PCM downlink contains operational data from the MDA life support systems and may require support. The ATM downlink contains experimental data and housekeeping parameters associated with the experiments. During a real-time experiment support situation, it will be necessary to sacrifice one of the operational downlinks to accommodate the experiments downlink. The AM system is the only operational system which does not serve a manned life support condition during the ATM experiment and is, therefore, the logical choice to sacrifice.

One method of avoiding the sacrifice of the AM downlink is to downlink the AM operational parameters through the LM or CSM. The total data rate of the AM is 4.03 kbps (excluding biomedical data) and could easily be accommodated by either of these systems. This method would require an interface between the AM and the selected vehicle. Thus, it appears that this method offers little advantage.

A second method of supporting this configuration is to periodically monitor the AM system during nonreal-time ATM experiments periods. This method appears feasible in that the AM system monitors the connecting life support system between the CSM and the LM/ATM. Real-time support of the AM system would be necessary prior to and during egress from CSM and during occupation of the MDA. However, the LM/ATM are not active at this time. Real-time support of the AM would also be desirable for ingress to the LM/ATM area. When the LM/ATM are activated and real-time experiments support is desired, the AM is then time shared at the remote site with the LM downlink. Table D-7 shows that three USB receivers and four VHF receivers are required to support the onboard systems. A single USB site can receive only two USB downlinks due to an RF equipment limitation.

TABLE D-7
CLUSTER CONFIGURATION GROUND STATION REQUIREMENTS

VEHICLE	REAL-TIME DOWNLINK	DUMP DOWNLINK
CSM	USB (PCM)	USB (FM)
AM	VHF (PCM)	VHF
ATM	VHF (PCM)	VHF
LM	USB (PCM)	

At the present time, Experiment S017 has its own data management system and VHF transmitter. As indicated in Table D-6, this downlink can be supported by the ground systems.

D.2.6 Data Management Systems

Figure D-5 following demonstrates two items:

- Four separate types of data management systems are employed in the cluster configuration of the OWS.
- The AM is physically and electrically located advantageously for data management system integration.

Previous analysis has shown that an adequate ground support equipment capability exists at the remote sites to support the cluster configuration except during the ATM experiment period. During this period, it is either necessary to time-share the AM downlink or record it for postpass processing. However, it is also necessary to consider the remote site data processor (RSDP) in reviewing the effect of the cluster configuration on the remote site. The six clustered vehicles with their four different types of DMS influence the RSDP as follows:

- Increase the number of input formats
- Increase the number of stored programs
- Increase the number of output formats
- Increase the core requirements
- Influence the remote site turnaround time
- Affect the output line use between the remote site and MCC-H.

Table D-8 depicts the various data management systems' capability and the actual use of these systems. Each of these systems is discussed following the table.

TABLE D-8
DATA MANAGEMENT SYSTEM CAPABILITY VS SYSTEM USE

VEHICLE	DMS SYSTEM	SYSTEM CAPABILITY	DATA-PROCESSED
CSM	APOLLO	51.2 KBPS	
LM	APOLLO	51.2 KBPS	
M&SS	ASTRIONICS	72.0 KBPS	NOT OVER 2.8 KBPS*
ATM	ASTRIONICS	72.0 KBPS	57.0 KBPS*
AM	GEMINI	51.2 KBPS	33.5 KBPS**
SO17	UNDEFINED	-----	1.6 KBPS

*Astrionics system encodes in 10-bit words.

**30.8 kbps of this data is biomedical data.

- A. M&SS. An independent DMS for the M&SS would mean that most of the Astrionics type data stream would be composed of fill data. The low bit rate could easily be absorbed by the CSM, LM, or AM operational downlink. It is anticipated that the M&SS data will be downlinked by the CSM during the first 5 days of AAP-1. Thus, the data management system should, in some way, be compatible with the CSM for integration into the downlink. The most feasible approach, from a ground support standpoint, would be to use a DMS on the M&SS which is compatible with the AM. This approach would downlink through the CSM subcarriers during the first 5 days of AAP-1, and could be integrated into the AM DMS downlink during the cluster configuration. Such an arrangement could be accomplished by using one subcommutator of an AM system and encoding the output in an 8-bit word.

M&SS
ASTRIONICS DMS
(72 KBPS)

S017
UNDEFINED DMS
(1.6 KBPS)

ATM
ASTRIONICS DMS
(72 KBPS)

AIRLOCK MODULE
GEMINI DMS
(51.2 KBPS)

CSM
APOLLO DMS
(51.2 KBPS)

LM
APOLLO DMS
(51.2 KBPS)

NOTES:

- (1) DMS - DATA MANAGEMENT SYSTEM
- (2) M&SS DMS CONSIDERED AS
INDEPENDENT

A5512(A)

FIGURE D-5 CLUSTER CONFIGURATION FOR DATA MANAGEMENT SYSTEMS

- B. S017. Detailed data is not available concerning the type of DMS under consideration for S017. The output bit rate of 1.6 kbps could be integrated into the AM, LM, CSM or ATM. This experiment will be performed normally in the MDA. The AM system is physically located in a prime position to support this experiment. Because the AM and MDA are physically connected throughout the lifetime of the vehicles, the S017 experiment should be integrated into the AM DMS before launch.
- C. CSM. The CSM DMS is a standard block II system. Part of this capability will be used for onboard experiments, i.e., Frog Otolith. The CSM does have the capability to process the M&SS data and can handle the associated command functions.
- D. LM. The LM DMS is a block II system. The decent stage of the LM will be removed, however, to accommodate the ATM experiment rack. The decent stage parameters will not be a part of the downlink telemetry stream. The LM functions as an operational part of, and is manned during, the ATM experiment. The LM DMS could not process the large quantity of ATM data. It could, however, be used in a back-up mode to process portions of the ATM experiments under a contingency situation.
- E. ATM. The ATM experiment represents the largest single source of data from the cluster configuration of the OWS. The conditions for experiment performance require that it operate in conjunction with the LM and CSM in the docked configuration as well as independently with the LM. Since the LM does not have the capability to process and downlink the complete ATM data, it becomes necessary to use a separate downlink for the ATM. The proposed type of DMS is an Astrionics system similar to that presently used in the IU. Using this system for the ATM removes or greatly restricts the possibility of integrating the ATM DMS with the other cluster configuration DMS because the Astrionics system is encoded in 10-bit words which increases its data rate by approximately 25 percent.

- F. AM. The proposed AM DMS is a Gemini system. The existing preliminary parameter list allocates approximately 30.8 kbps to the operational biomedical data. This rate greatly reduces the data handling capability of the AM in processing experiments data. This area is explored in subsequent paragraphs and alternate methods presented for processing this biomedical data. The AM is centrally located in the cluster configuration and, as such, it provides an ideal interface area for systems integration. An attempt will be made in subsequent paragraphs to analyze methods reducing the number of downlinks and formats from the OWS by using the AM systems. Such a capability would relieve some of the burden on the remote sites.

D.3 AIRLOCK MODULE BIOMEDICAL DATA

D.3.1 Purpose of Analysis

This analysis will examine the biomedical data requirements for the AM. Techniques for downlinking the data will be explored to determine the best approach to processing the AM data. The emphasis in this analysis is to simplify the ground processing methods in handling the biomedical data.

D.3.2 Analysis Approach

The analysis defines the biomedical data management methods associated with the Gemini system in the AM and the Apollo system in the CSM. The various approaches to processing and downlinking the data will be presented. The biomedical data processing scheme at the remote site will be analyzed and limitations established. Conclusions and recommendations will be drawn from the analysis.

D.3.3 Analysis

D.3.3.1 General

The Apollo biomedical data from the CSM is time-shared between the three astronauts. Each astronaut has the necessary biomedical sensors attached; however, the input to the onboard telemetry system for biomedical data is controlled by a three-position switch so that biomedical data from only one crew member at a time is processed by the telemetry system.

In the OWS configuration, the AM and LM have the capability to downlink biomedical data. During EVA, another biomedical downlink exists via LM. The following capabilities exist in the cluster configuration:

- A. AM. The 51.2 kbps VHF telemetry downlink can contain the biomedical parameters for two astronauts. This data could be downlinked simultaneously over a Gemini type data management system.

- B. CSM. The CSM 51.2 kbps USB telemetry data contains the biomedical data for one astronaut.
- C. LM. The biomedical data from the LM is processed on a 14.5-kilocycle oscillator which modulates the 1.25-megacycle voice subcarrier of the USB downlink. Only one of the two crew member's EKG can be processed at any one time. During an EVA, the LM can downlink the EVA biomedical data and its crew members' biomedical data on the 1.25 voice subcarrier of the USB.
- D. OWS. The biomedical data from the orbital workshop is routed through the AM telemetry system and is downlinked through the AM VHF downlink.
- E. EVA. Biomedical data can be processed through the CSM or LM by modulating the 1.25 megacycle USB voice subcarrier. The present AM system does not have a VHF receive and process capability for biomedical data, and any EVA data to be processed by the AM would have to be routed to the AM by an umbilical cord. Table D-9 shows various combinations of conditions that exist for biomedical data.

D.3.3.2 CSM Biomedical Data Requirements

The biomedical data from the CSM is normally downlinked through the PCM telemetry. The existing biomedical parameters for one astronaut in the CSM telemetry format are summarized below.

- One EKG sampled at 200 sps
- One EKG sampled at 200 sps
- One Impedance Pneumograph sampled at 50 sps
- One Switch Position Monitor at 10 sps.

TABLE D-9
CONDITIONS FOR BIOMEDICAL DATA

CONDITION	BIOMEDICAL DOWNLINKS		
	CSM	LM	AM
EVA FROM AM	CSM CREW MEMBER EVA CREW MEMBER		AM CREW MEMBER
OWS/MDA/AM EXPERIMENTS	CSM CREW MEMBER		AM CREW MEMBERS (TWO)
ATM EXPERIMENTS	CSM CREW MEMBER	EITHER BUT NOT BOTH CREW MEMBERS OF LM/ATM*	

*THE TECHNIQUE FOR ROUTING BIOMEDICAL DATA FROM THE ATM EXPERIMENT AREA IS NOT DEFINED. THE BIOMEDICAL DATA DOES NOT APPEAR IN THE ATM DOWNLINK FORMAT SO IT IS ASSUMED THAT A COBRA CONNECTION WILL EXIST, WHEREBY, THIS BIOMEDICAL DATA IS ROUTED TO THE ENGINEERING POSITION IN THE LM. THE DATA CAN THEN BE SELECTED BY THE COMMAND POSITION IF REQUIRED.

Each sample is downlinked as an 8-bit word. Thus, the following bit count for biomedical data exists in the CSM PCM telemetry:

- One EKG at 1600 bps
- One EKG at 1600 bps
- One ZPG at 400 bps
- One Switch Position Monitor at 80 bps.

The total bit count for biomedical data in the CSM is 3680 bps.

D.3.3.3 Airlock Module Biomedical Data Requirements

The presently proposed biomedical requirements for the AM follow the Gemini Data Management System for biomedical data. In the AM TLM commutation scheme, the parameters and their sampling rates required the sampling of 6 biomedical parameters at a rate of 640 sps and 2 parameters at 1.25 sps. Each sample is downlinked as an 8-bit word. The total biomedical bit count for the AM system is $(6 \times 640 \times 8 + 2 \times 1.2 \times 8 = 30,720 + 20)$ 30,740 bps. The total capability of the AM Data Management System is 51,200 bps. Therefore, only 20,460 bits of the downlinked data stream are available for AM operational parameters and experiments.

Such an arrangement of biomedical data in the AM loads the AM system with 30,740 bps of biomedical data presented in Figure D-6, and it leaves only 20,460 bps for OWS operational parameters and experiment requirements. According to the preliminary AM TLM Parameter List, the CSM downlinked biomedical data and the preliminary airlock biomedical data to be downlinked greatly exceed the data necessary to monitor the biomedical functions in the AM when considering the CSM biomedical data requirements.

D.3.3.4 Airlock Module Biomedical Data Management

In order to analyze the capabilities and effects of the Gemini biomedical data technique, the analysis assumes that the

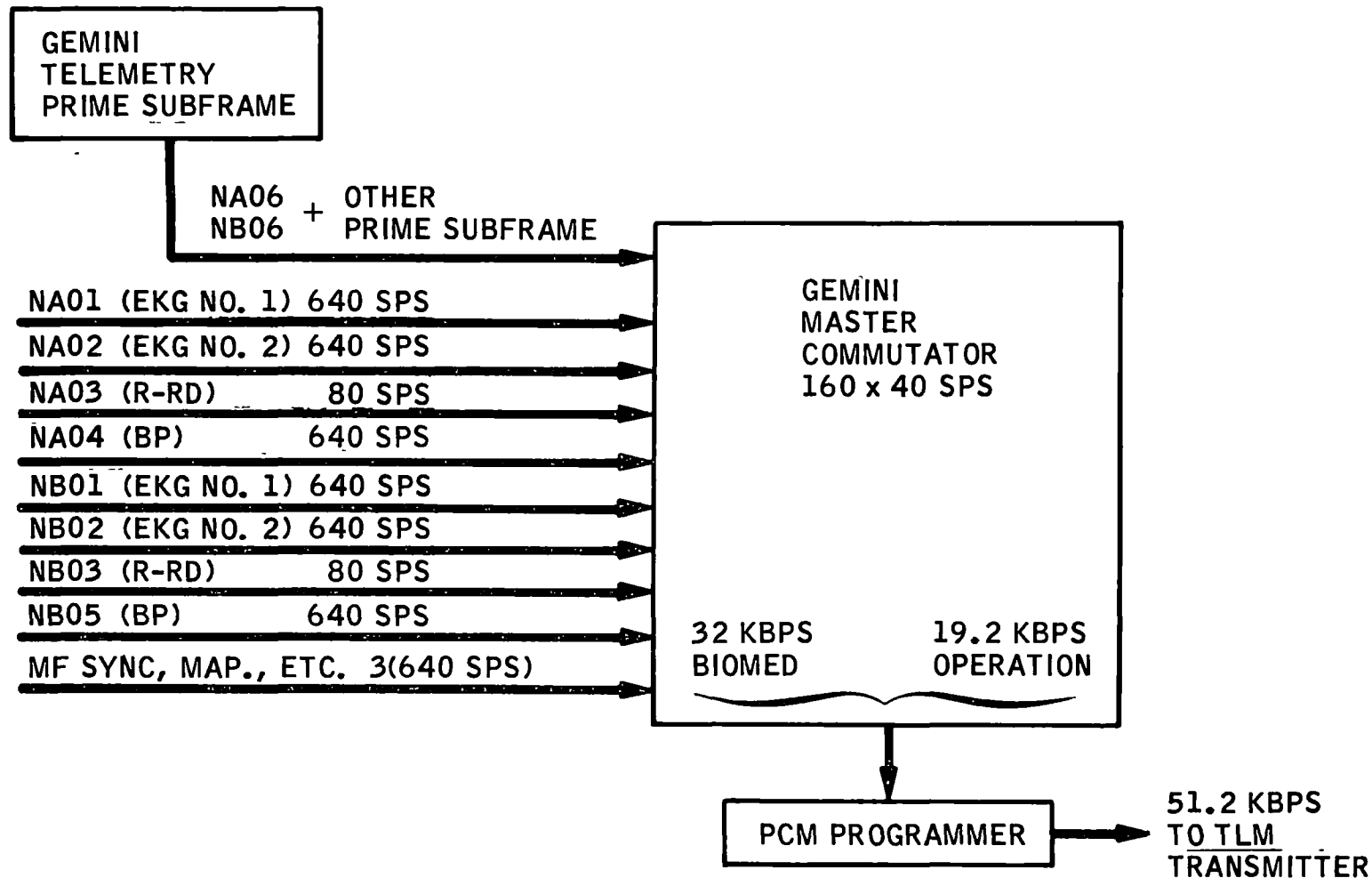


FIGURE D-6 SIMPLIFIED BLOCK OF AM BIOMEDICAL DATA HANDLING
BY GEMINI TELEMETRY SYSTEM

A5513 (A)

biomedical requirements for each astronaut in the AM does not exceed the biomedical requirements for a single astronaut in the CSM. The biomedical requirements for each astronaut in the AM are then:

- One EKG at 200 sps = 1600 bps
- One EKG at 200 sps = 1600 bps
- One ZPG at 50 sps = 400 bps

When this assumption is made, three conditions for downlinking the AM biomedical data occur:

- A. Condition 1. Under this condition, biomedical data is required simultaneously from both astronauts in the AM. The parameters required for the two crew members data can be subcommutated into the VHF PCM stream as given in Figure D-7. The total bit requirement for the two crew members is 7200 bps. The remaining 44,000 bps in the AM telemetry stream can be allocated to OWS housekeeping and experiments data.
- B. Condition 2. This condition provides for the time-sharing of the biomedical data among the astronauts in the OWS area. This can be accomplished through a selection switch similar to the selection switch scheme used in the CSM. It is necessary to monitor the switch position in this scheme (refer to Figure D-8). By time-sharing, the astronauts biomedical data is reduced to 3680 bps leaving 47,520 bps for OWS housekeeping and experiments parameters.
- C. Condition 3. This condition provides for the routing of both OWS crew members biomedical data through a suitable interface to the CSM. In the CSM, one of the three astronauts data is selected in the normal selection manner and routed through the CSM telemetry system to be downlinked. This method has several distinct advantages.
 1. It follows the selection technique established in the Apollo biomedical data handling. Since the CSM is always manned, crew selection is always available.

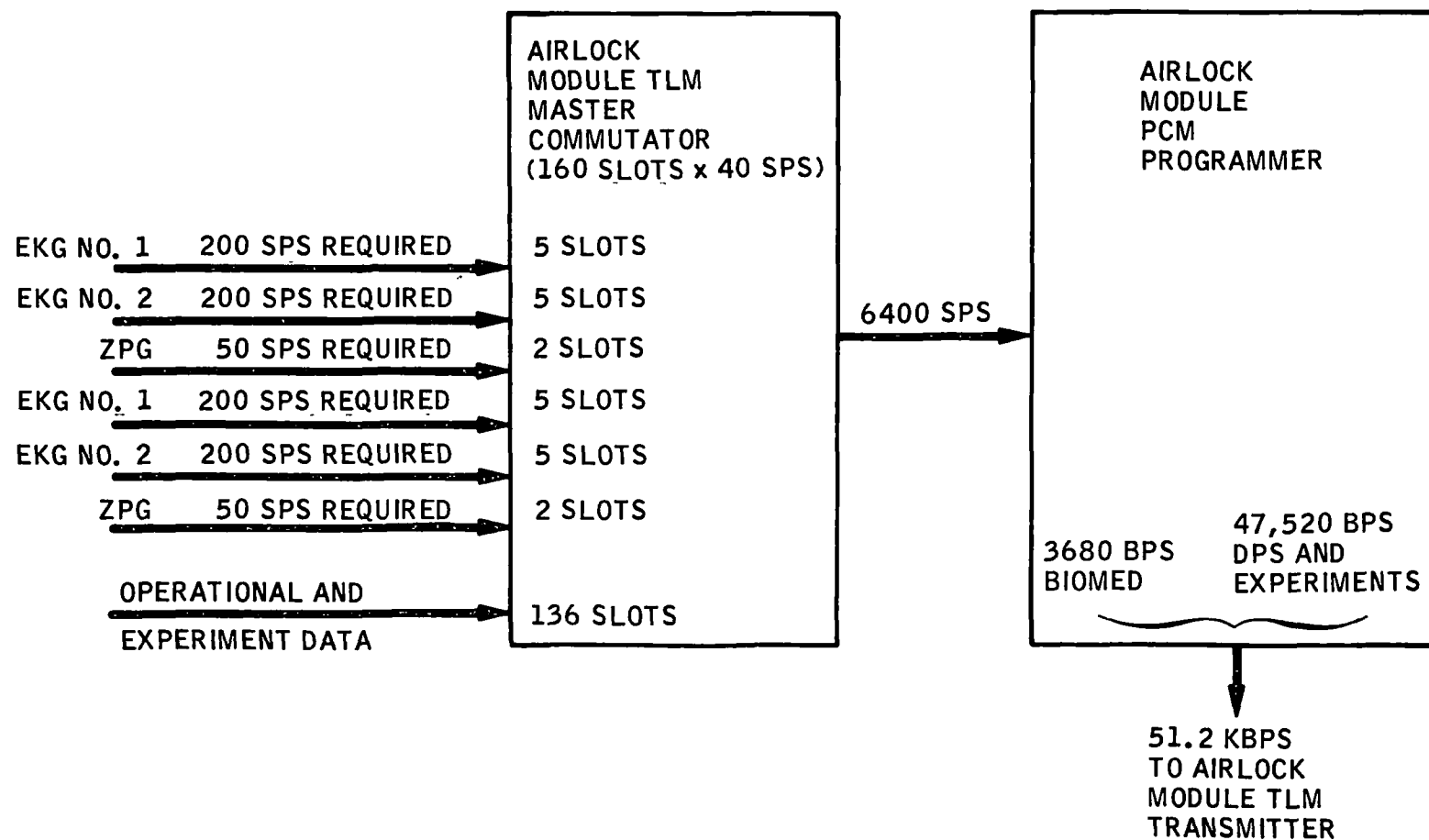


FIGURE D-7 BIOMEDICAL DATA INTERFACE TO AM TELEMETRY SYSTEM
AS USED SIMULTANEOUSLY BY TWO ASTRONAUTS (CASE 1)

A5514 (A)

D-28

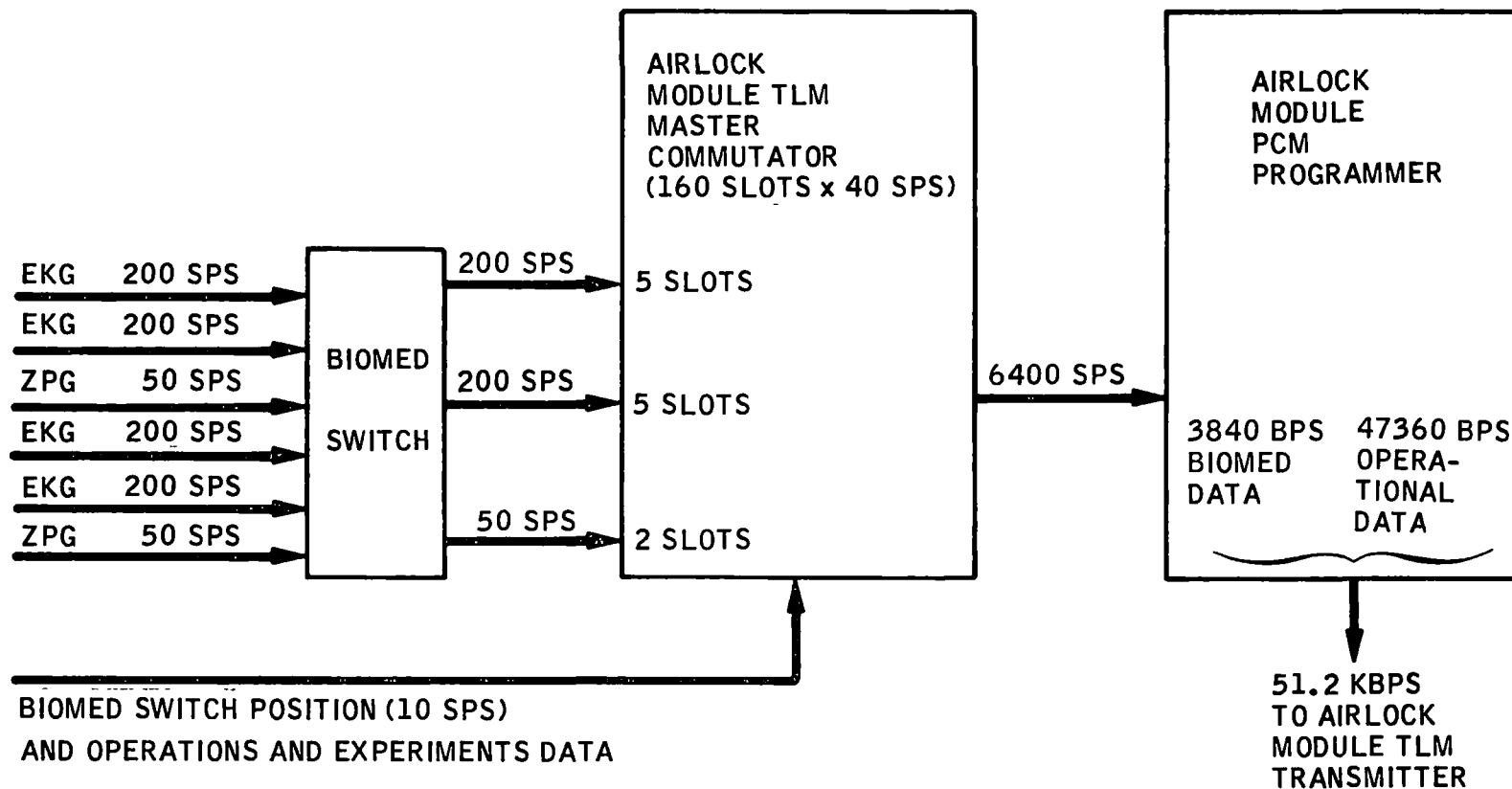


FIGURE D-8 BIOMEDICAL DATA INTERFACE TO AM TLM AS SWITCHED BETWEEN TWO ASTRONAUTS (CASE 2)

A5515(A)

2. It consolidates the operational biomedical data into one PCM telemetry downlink. The CSM operational downlink requires support throughout the mission. Consolidation simplifies the remote site PCM ground station processing of the biomedical data.
3. It frees the AM telemetry system (51.2 kbps) for use on AM operational parameters and OWS experiments data. There is a disadvantage here in that a CSM interface for AM biomedical data is required.

D.3.3.5 Remote Site Biomedical Processing

The PCM ground station at the remote site operates on the PCM telemetry downlink and strips out the biomedical data which is routed to digital-to-analog converters. These convert the digital data to analog data and input to voltage controlled oscillators which frequency division multiplex the data on to a 3 kilocycle voice line. This line has the first 8 interranger instrumentation group telemetry channels established across the 3 kilocycle bandwidth. Normal assignment would apply the two EKG's from an astronaut to Channels 7 and 8 and the impedance pneumograph to Channel 6. Bandwidth limitations in Channels 1 through 5 limit their use to low sampling rates. Either Channel 4 or 5 would contain the onboard biomedical switch position.

Under normal operating conditions, the remote site is configured to support only one astronaut's data. This configuration is primarily concerned with CSM data. When the LM is occupied in conjunction with the CSM and an EVA occurs, the possibility of receiving an EKG from three separate crew members exists. Some consideration has been given to arranging the remote site to transfer these three EKG's over IRIG Channels 6, 7 and 8.

An analysis of the AM onboard biomedical data management has shown that the AM can be implemented to simultaneously downlink biomedical data at the CSM rate from two crew members. This data can be downlinked simultaneously with the CSM biomedical

data. Thus, the possibility exists that three sets of biomedical data can be simultaneously downlinked to the remote site. As previously stated, the site is configured to handle and transfer biomedical data from only one astronaut at a time. Several approaches can be taken to solve this problem.

- A. The first and most expensive technique would be to implement additional biomedical lines with additional IRIG channels.
- B. The second approach is to process one astronaut's data in real-time and the other crew members' data postpass.
- C. A third approach is to output partial biomedical data from each astronaut, i.e., one EKG from each crew member.
- D. The fourth method is to provide for time-sharing the output by each crew member. This approach can be accomplished by implementing the remote site; however, it could also be time-shared onboard as previously suggested without remote site modification.

D.4 AIRLOCK MODULE TELEMETRY COMMUTATION SCHEME

The master commutator has 160 slots each that are sampled 40 times per second. Forty-eight of these slots are assigned to 3 submultiplexers, each of which have 16 slots sampled at 40 times per second. The remaining 112 slots of the master commutator are supercommutated with 16 slots assigned to each input signal, which results in a sampling rate of 640 sps for each input. One of the groups of 16 slots is assigned to the prime subcommutator which contains 64 slots, each of which is sampled at 10 times per second. These 64 slots are grouped into 16 groups of 4 slots each. Eight of the 4-slot groups are assigned to sub-submultiplexers, each of which has 4 slots, and each sampled at 10 sps. Five other 4-slot groups of the prime subcommutator are assigned to 5 multiplexers (i.e., 3 high-level multiplexers and 2 low-level multiplexers), each of which contains 4 slots sampled at 10 sps. Two of these multiplexers have one slot assigned to a lower sample rate multiplexer that has 24 input slots, each sampled at .416 sps. One of the slots of each of these two multiplexers is assigned to a sub-multiplexer having 8 slots, each sampled at 1.25 sps.

Three of the multiplexers having 4 slots sampled at 10 sps have each of their 4 slots assigned to a multiplexer that has 8 slots sampled at 1.25 sps. Each of these high-level multiplexers is associated with 5 gates, each of which sample 8 bilevel inputs. These bilevel inputs are 1-bit words and are sample-loaded into the 8-bit output register. The timing and programming system provides pulses which gate these bilevel words into the 51.2 kbps stream when certain slots in the analog multiplexers output nothing. During this time, the analog-to-digital converter does not output a parallel bit word into the output shift register. A total of 24-bit computer words from the spacecraft computer are output through a gate to a 24-bit register. The 24-bit word is output to the output shift register in 8-bit parallel words when certain slots in the prime subcommutator contain no data. The sequence of the interleaving of digital data is controlled by the PCM programmer timing system. The output from the output shift register is 6400 8-bit words per second or 51.2 kbps. A summary of the Gemini telemetry system characteristics and capabilities follows.

A. Gemini Format

- Data rate 51.2 kbps real-time
- Dump rate 112.64 kbps
- Number of parameters
- 40 frames per second
- 160 words per frame
- 8 bits per word
- $8 \times 160 \times 40 = 51.2$ kbps
- 24-bit sync pattern.

B. Gemini Prime Subframe

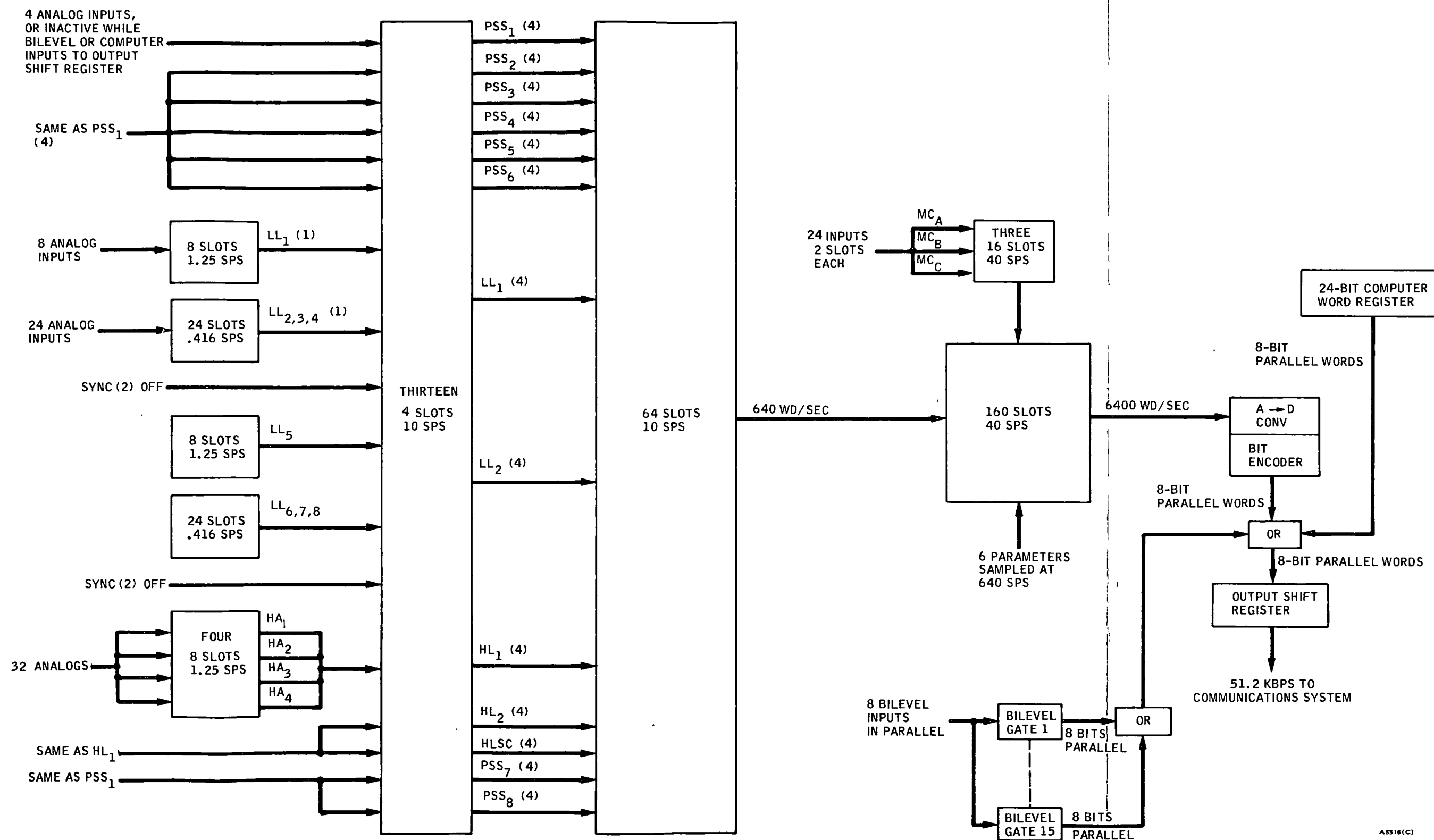
- 16 words per mainframe
- 4 mainframes per pass
- 64 words per GPSF
- Subcommutated at 1:8 and 1:24
- 24-bit sync pattern once per pass
- GPSF sync pattern 0110110011110101000xxxxx
(subframe count).

C. Total Measurement. The total measurement capabilities of the Gemini telemetry system (as configured for GT-4) are as follows:

- 117 low-level (0-20 megavolts) analogs
- 108 high-level (0-5 vdc) analogs
- 32 bilevel pulses

- 88 bilevel
- 24 digitals (24-bit).

Figure D-9 is a simplified block diagram of the Gemini commutation system. Table D-10 is a tabulation of the commutator slots and their sampling rates.



A5516(C)

FIGURE D-9 SIMPLIFICATION OF GEMINI TELEMETRY EQUIPMENT

TABLE D-10
GEMINI TELEMETRY EQUIPMENT

	COMMUTATOR	NO. OF SLOTS	SAMPLING RATE
MC	MASTER COMMUTATOR (640 SPS)	160	40.0 SPS
	MC (80 SPS)	16	40.0 SPS
	MC (80 SPS)	16	40.0 SPS
	MC (80 SPS)	16	40.0 SPS
PS	PRIME SUBCOMMUTATOR	64	10.0 SPS
	PS ₁ (10 SPS)	4	10.0 SPS
	PS ₂ (10 SPS)	4	10.0 SPS
	PS ₃ (10 SPS)	4	10.0 SPS
	PS ₄ (10 SPS)	4	10.0 SPS
	PS ₅ (10 SPS)	4	10.0 SPS
	PS ₆ (10 SPS)	4	10.0 SPS
	PS ₇ (10 SPS)	4	10.0 SPS
	PS ₈ (10 SPS)	4	10.0 SPS
HS	HIGH-LEVEL SUBCOMMUTATOR	4	10.0 SPS
	HS ₁	8	1.25 SPS
	HS ₂	8	1.25 SPS

TABLE D-10 (CONT'D)

	COMMUTATOR	NO. OF SLOTS	SAMPLING RATE
LR	HS ₃	8	1.25 SPS
	HS ₄	8	1.25 SPS
	LOW-LEVEL MULTIPLEXER (REENTRY)		
	(10 SPS) MULTIPLEXER	4	10.0 SPS
	LR ₁	8	1.25 SPS
	LR ₂	8	0.416 SPS
	LR ₃	8	0.416 SPS
	LR ₄	8	0.416 SPS
LA	LOW-LEVEL MULTIPLEXER (ADAPTER)	4	10.0 SPS
	LA ₁	8	1.25 SPS
	LA ₂	8	0.416 SPS
	LA ₃	8	0.416 SPS
	LA ₄	8	0.416 SPS
HR	HIGH-LEVEL MULTIPLEXER (REENTRY)	4	10.0 SPS
	HR ₁	8	1.25 SPS
	HR ₂	8	1.25 SPS

TABLE D-10 (CONT'D)

	COMMUTATOR	NO. OF SLOTS	SAMPLING RATE
HA	HR ₃	8	1.25 SPS
	HR ₄	8	1.25 SPS
	HIGH-LEVEL MULTIPLEXER (ADAPTER)	4	10.0 SPS
	HA-1	8	1.25 SPS
	HA-2	8	1.25 SPS
	HA-3	8	1.25 SPS
	HA-4	8	1.25 SPS

D.5 SYSTEMS INTEGRATION

It has been shown that the AM telemetry system has a large excess of data measuring capabilities beyond those required for the AM operational data. This is especially true if the biomed data from astronauts in the AM is sampled at the same rate and number as in the CSM. The AM telemetry system (51.2 kbps) can be used for downlinking data from other members of the AAP mission when they are docked and properly interfaced to the AM telemetry system. The sampling rates of the AM telemetry system range from 640 sps to .416 sps. An analysis of the parameters of the other AAP experiments and their sampling rates indicates that many of these parameters could be downlinked via the AM telemetry system.

It is understood that electrical interface problems arise when parameters from one vehicle are sensed and downlinked by another. However, it is considered important to effectively utilize the onboard telemetry systems so that remote sites will not be burdened with numerous space-to-ground links which are only partially filled with useful data. As more space vehicles are simultaneously placed into orbit, the remote site load and the RF spectrum utilization may exceed existing and planned network capabilities. Therefore, it is anticipated that future cluster missions will require extensive electrical interfacing in order to minimize the downlink problem.

The results of an analysis of the proposed AM telemetry system are presented in the following paragraphs in order to demonstrate the capability of the AM telemetry system acting as a central onboard data collection and downlinking system for several other vehicles. Table D-11 shows the bit rate capability of the AM, and the preliminary data requirements of SO17, the ATM, and the AM operational data are presented in Tables D-12, D-13 and D-14. All of the AAP experiments do not require simultaneous support since in most cases the astronauts in the OWS will perform only one experiment at a time. Table D-11, however, tabulates the ATM SO17 bit rate requirement as well as the AM housekeeping parameters as if simultaneous support was required. The purpose is to show the capability of the AM telemetry used to integrate or act as a backup system to the ATM, SO17, and other AAP experiments.

TABLE D-11
AM HOUSEKEEPING DATA REQUIREMENTS¹

DATA TYPE	SAMPLE RATE	BITS PER SAMPLE	TOTAL BIT RATE
42 BILEVELS	10.0 SPS	8	480 BPS
25 HL	1.25 SPS	8	250 BPS
4 HL	10.0 SPS	8	320 BPS
24 LL	0.416 SPS	8	80 BPS
8	1.25 SPS	64	80 BPS
3	80.0 SPS	8	1920 BPS
1	0.416 SPS	8	3.328
			3133 BPS ²
ADDITIONAL PARAMETERS ³			
DATA TYPE	SAMPLE RATE	BITS PER SAMPLE	TOTAL BIT RATE
46 BILEVELS	10.0 SPS	8	460.0 BPS
35 HL	1.2 SPS	8	336.0 BPS
9 L	1.2 SPS	8	86.4 BPS
44 LL	0.42 SPS		18.5 BPS
5 BL	0.42 SPS	8	2.1 BPS
			903.0 BPS ²
TOTAL = 4036.0 BPS			

NOTES:

¹ Taken from Preliminary AM Instrumentation List.

² This quantity does not contain biomed data.

³ Additional parameters recommended by a Review of Airlock Preliminary Telemetry List, 28 February 1967.

TABLE D-12
 ALLOCATION OF AM TELEMETRY BIT STREAM
 FOR OTHER EXPERIMENT SYSTEMS¹

VEHICLE SYSTEM	DATA RATE
CAPABILITY OF AM TELEMETRY	+51.2 KBPS
AM HOUSEKEEPING DATA ²	-4.036 KBPS
ATM EXPERIMENT'S DATA S052, S053, S054, S055, S056 ³	-6.112 KBPS
ATM HOUSEKEEPING DATA	-36.64 KBPS
ATM ASTRONAUTS DATA DISPLAYED ONBOARD AND DOWNLINKED	<u>-3.456 KBPS</u>
EXCESS DATA CAPABILITY REMAINING	0.956 KBPS

NOTES:

¹ This allocation of bit count into the AM telemetry system is not necessarily the most effective use of the AM system. This table shows that the AM can handle the two subject data requirements in toto.

² AM housekeeping data does not include the biomed requirements as was proposed in a preliminary AM measuring list.

³ Refer to Figure D-10 for break out of ATM parameters.

TABLE D-13
ATM TELEMETRY REQUIREMENTS¹

NO. OF PARAMETERS	SAMPLING RATE	NO. OF SAMPLES PER SECOND
4	387	1548
120	21	2520
12	51	612
24	24	576
40	13	<u>520</u>
		5776

The bit rate of proposed ATM telemetry is 10×5776 or 57,760 bps. In order for the AM to handle this data, the data would be encoded as an 8-bit sample in lieu of a 10-bit sample. The 8-bit sample would reduce the 57,760 bps to 46,208 bps.

NOTE:

¹This data was derived from an Instrumentation Program Components List for ATM Rack (ATM#), 4 January 1967.

TABLE D-14

ATM EXPERIMENTS DATA AND ASTRONAUT MONITORED DATA*

ATM EXPERIMENT	NUMBER OF PARAMETERS	SAMPLE RATE	TOTAL SAMPLES PER SECOND	BIT RATE
S052	13	4	52	520
	RECORDED 10	1		
S053	31	4	124	1240
	RECORDED 19	1		
S054	12	4	48	480
	RECORDED 12	1		
S055	56	4	224	2240
	RECORDED 36	1		
	24	12	288	2880
	RECORDED 12	24		
S056	7	4	28	280
	RECORDED 2	4		
	RECORDED 5	1		
ASTRONAUT PANEL	75	4	300	3000
	1	12	12	120
	1	120	120	1200
TOTAL EXPERIMENTS ASSOCIATED DATA				11,960 BITS PER SECOND

*DATA EXTRACTED FROM INSTRUMENTATION PROGRAM AND COMPONENTS LIST
FOR ATM RACK DATED 4 JANUARY 1967.

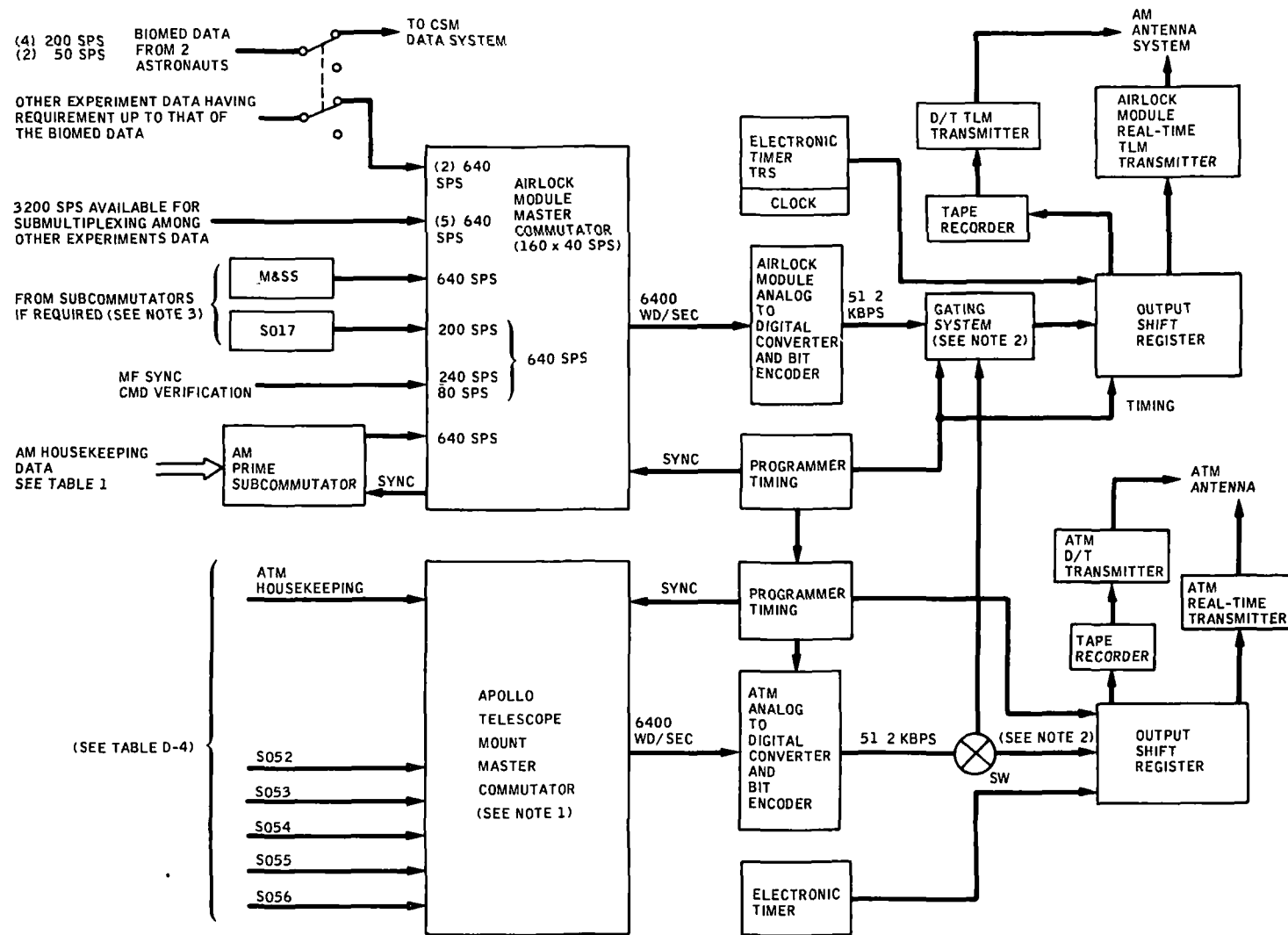
The data sensors of the vehicles of the OWS could be fed into the AM telemetry system by hardwiring each parameter to the AM telemetry system. This method requires a large electrical/mechanical interface between vehicles. Another method which appears feasible for routing experiments data to the AM from other vehicles of the cluster is to provide AM submultiplexers for each vehicle or experiment. Using the submultiplexer approach, only a signal path to the AM master commutator and a sync path to the submultiplexer from the AM timing system is required, thus simultaneously reducing any interface problems. A manual or command central switching system could provide selection of the submultiplexer associated with the experiment currently in progress. A list of the advantages and disadvantages of using a common data management follows.

A. Advantages

1. Minimizes the number of downlinks to be received by remote site equipment.
2. Assures transmission of experiments data in conjunction with the operational data.
3. Reduces the RFI problem in having a large number of transmitters in close proximity.
4. Minimizes space, power, and weight requirements of total vehicles.
5. Provides redundancy to vehicles requiring independent telemetry systems compatible with that of the common telemetry system of the AM.
6. Reduces remote site turnaround time and effort by using a set commutation scheme which can be processed as operational and which contains experiments data.
7. Assures experimenter of getting the experiment data since it is part of the operational downlink of the AM.

8. Reduces data correlation problems between the experiments and operational data.
 9. Minimizes the requirements on the RF spectrum assigned to space communications.
 10. Reduces antenna pattern problems.
- B. Disadvantage. The major disadvantage of the common data management system is its requirement for vehicle electrical interfaces.

In an attempt to establish an OWS common data management system, a detailed analysis of the AM (Gemini) telemetry commutation scheme was made. It has been presented herein, along with Figure D-10 to show how the other vehicles might be interfaced to the AM telemetry system.



NOTES

- (1) THE ATM IS PRESENTLY PROPOSED TO HAVE A 72 KBPS TLM SYSTEM SIMILAR TO THE IU PCM TLM SYSTEM. THE SYSTEM CONSIDERED IN THIS CONCEPT IS IDENTICAL TO THAT OF THE AM SO THAT THEIR DATA CAN BE INTERLEAVED INTO A SINGLE DOWNLINKED STREAM.
- (2) THESE ARE DEVICES NOT CURRENTLY A PART OF THE PROPOSED AM TLM SYSTEM.
- (3) THESE TWO EXPERIMENTS IN THIS CONCEPT HAVE DATA MANAGEMENT SYSTEMS WHICH OUTPUT DATA COMPATIBLE WITH THE AM TLM SCHEME.

A9817(C)

FIGURE D-10 AIRLOCK MODULE CENTRALIZED DATA MANAGEMENT CONCEPT

APPENDIX E
MISSION SUPPORT ANALYSIS

E.1 PURPOSE

This analysis examines the current mission profile with emphasis on operational and experimental data support. Consideration is given to all experimental activity support.

E.2 ANALYSIS APPROACH

Four missions are considered in this analysis. To simplify the approach, the missions have been grouped into series A and B missions as given below.

<u>Series</u>	<u>Mission</u>	<u>Orbital Vehicles</u>
A	AAP-1	CSM/M&SS
	AAP-2	SIVB/IU/AM/MDA
B	AAP-3	CSM
	AAP-4	LM/ATM

Each mission is investigated in areas concerning the specific mission events and experiment periods. Support considerations are developed and problem areas discussed where applicable.

E.3 ANALYSIS

E.3.1 Series A Missions

E.3.1.1 General

The initial flight of the AAP will be AAP-1 which will be launched from complex 34. The launch vehicle payload will be a manned CSM and the M&SS. This payload will be inserted into a 128 nautical mile circular orbit. The planned duration of the AAP-1 CSM in earth

orbit is 28 days. The M&SS will be docked to the OWS during AAP-2 and will remain docked throughout the OWS lifetime.

During the first 2 hours of the mission, the CSM will separate from the SIVB/IU, will dock with the M&SS, will extract the M&SS, and will perform final separation from the SIVB/IU.

The next 5 days of the mission are expended in performing the operational and experimental tasks associated with testing and evaluating the M&SS in a space environment. The lunar orbital activity periods for the M&SS will be simulated during this period. After completing the M&SS experiments, the M&SS system is placed in a passive mode, and the CSM enters a coast phase while waiting for the launch of AAP-2.

AAP-2 is launched approximately 5 days after AAP-1. The orbital payload for AAP-2 is the orbital workshop which consists of a modified SIVB/IU, an AM and an MDA. AAP-2 is launched from launch complex 37B and is inserted at an altitude of 270 nautical miles into a circular orbit. The CSM is trailing the orbital workshop by a central angle of approximately 24 degrees at insertion. The rendezvous by the CSM with the OWS consists of three SPS burns each of which is preceded by an RCS ullage burn. Terminal phase initiation is accomplished with the RCS engines. Terminal phase finalization maneuver associated with rendezvous is also accomplished with the RCS engines.

The M&SS is transported to the OWS by the CSM after rendezvous, the M&SS is soft docked to a radial port of the MDA. An EVA period is then performed to recover the M&SS data packages and to disconnect the M&SS umbilical from the CSM. The crew members reenter the CSM, secure latches, and undock from the M&SS. The CSM is then soft docked on the opposite radial port. The crew performs harddocking of the CSM to the MDA under EVA conditions, then will enter the MDA and hard dock the M&SS to the MDA. During the next 23 days of the mission the crew performs the OWS experiment series. The initial 9 days of this period are spent in activating the orbital workshop (Experiment M402) and determining the habitability (Experiment M487) of the OWS.

On the 27th day, the CSM separates from the OWS approximately 3 hours prior to the deorbit maneuver period. The planned deorbit maneuver consists of a 17-second RCS ullage maneuver and a 28-second SPS engine burn. The selected landing site is in the Atlantic Ocean and the deorbit maneuver is performed over the Pacific Ocean.

E.3.1.2 AAP-1 Launch

The ALDS is called to support launch. The downlinks from the launch vehicle and the CSM are given in Table E-1. The primary CSM downlink is via USB systems, however, a VHF voice backup transmitter and C-band transponder are also radiating from the CSM. The M&SS experiments package is contained in the SLA panels of the SIVB/IU and is inactive. (Since the M&SS radiates through the CSM USB (FM) downlink, it could be activated and supported during launch. An electrical interface would have to be provided, however, to interface the CSM and M&SS as this interface does not exist at launch.) Adequate ground support exists from the ALDS to support launch through insertion with insertion support provided by Bermuda. The data downlinked from the CSM during launch is operational data. Experiments will not be performed by the crew during launch and, therefore, experiments data will not be downlinked from the CSM. Normal operational PCM telemetry is downlinked from the launch vehicle and is processed through the ALDS to the MCC-H for evaluation.

E.3.1.3 CSM Separation, Transposition, and Docking to M&SS

Approximately 2 hours after liftoff, the CSM separates from the launch vehicle, the SLA panels are deployed, and the CSM transposes and docks with the M&SS. The CSM/M&SS are hard docked during the following 30 minutes and then permanently separated from the SIVB/IU. Thus, the M&SS payload is extracted approximately 4 hours after launch which is within the lifetime of the SIVB/IU.

The venting requirements for the SIVB have not been defined. Since there is no restart requirement for the SIVB engine after the ascent and insertion maneuvers, it is assumed that the fuel tanks are vented continuously thereafter.

TABLE E-1
SUPPORT OF SERIES B MISSION EVENTS

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
AAP-1 LAUNCH					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	RSO - RANGE SAFETY OFFICE FC - FLIGHT CONTROL P - PRIMARY DOWNLINK B - BACKUP DOWNLINK N/A - NOT APPLICABLE LAUNCH SUPPORTED BY ALDS. PRIME SUPPORT SITES ARE KSC, GBM, ANT & BDA. M&SS ASSUMED INACTIVE DURING LAUNCH ALTHOUGH IT DOES NOT APPRE- CIABLY AFFECT GROUND SUPPORT.
SIVB/IU	N/A	C-BAND	2 VHF (PCM) 2 VHF (PAM)	UHF (RSO) (FC)	
SIB	N/A		VHF (PCM) VHF (PAM)	UHF (RSO)	
CSM TRANSPOSITION, DOCKING AND EXTRACTION					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THIS MANEUVER IS INITIATED OVER ACN. A TAN PASS FOLLOWS THE ACN PASS. MANEUVER IS INITIATED IN DARKNESS. SOFT DOCKING OCCURS OVER CRO IN DAYLIGHT. EXTRACTION OCCURS OVER HAW ON THE NEXT REVO- LUTION.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	
CSM - M&SS ORBITAL SUPPORT					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB (FM) USB (FM)	USB	M&SS DOWNLINKED THROUGH THE CSM SCIENTIFIC SUBCARRIERS ON THE USB (FM) DOWNLINK.

TABLE E-1 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
AAP-2 LAUNCH					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THE AM DOWNLINK IS CONSIDERED INACTIVE FOR LAUNCH. THE CSM AND LAUNCH VEHICLE ARE NOT SUPPORTED SIMULTANEOUSLY BY A REMOTE SITE. AM IS INSERTED INTO 270 NAUTICAL MILES CIRCULAR ORBIT. SUPPORT IS FOR LAUNCH BY KSC, GBM, ANT & BDA. AAP-2 LEADS AAP-1 IN CENTRAL ANGLE.
SIVB/IU	N/A	C-BAND	2 VHF (PCM) 2 VHF (PAM)	UHF (RSO) UHF (FC)	
SIB	N/A	N/A	VHF (PCM) VHF (PAM)	UHF (RSO)	
CSM PHASING MANEUVER (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THIS IS A 2.1-SECOND SPS ENGINE BURN WHICH OCCURS OVER TAN. THE VEHICLES ARE NOT SUPPORTED SIMULTANEOUSLY BY A REMOTE SITE. TRACKING FOR BURN FROM KSC. UPDATE FROM CYI.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	
CSM CORRECTIVE COMBINATION MANEUVER (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THIS IS AN 11.7-SECOND SPS BURN AND DOES NOT OCCUR OVER A REMOTE SITE. A SHIP IS REQUIRED IF THIS BURN IS TO BE SUPPORTED. VEHICLES ARE NOT SUPPORTED SIMULTANEOUSLY BY REMOTE SITE. TRACKING IS BY CRO AND UPDATE FROM HAW. THIS UPDATE IS NOT WITHIN THE FCD GROUNDRULE OF 30 MINUTES PRIOR TO ENGINE BURN.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	

TABLE E-1 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
CSM CORRECTIVE COMBINATION MANEUVER (SPS) (CONT'D)					
					HOWEVER, THESE ARE THE ONLY SITES AVAILABLE UNLESS TAN HAS USB CAPABILITY AND ADEQUATE TRACKING TIME.
CSM COELLIPTICAL MANEUVER (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THIS IS AN 8.9-SECOND SPS BURN. OVER PRE. PRE CAN SUPPORT ONLY VHF VOICE. TAN AOS IS APPROXIMATELY 4 MINUTES AFTER THE BURN. TRACKING FOR BURN FROM GYM AND TEX. UPDATE FROM KSC OR GBM. VEHICLES ARE NOT SUPPORTED SIMULTANEOUSLY BY REMOTE SITE.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	
CSM TERMINAL PHASE INITIATION (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THIS IS A 53.7-SECOND RCS BURN. TRACKING PRIOR TO BURN FROM HAW. UPDATE FOR BURN FROM KSC. BURN OCCURS OVER PRE. VEHICLES ARE NOT SUPPORTED SIMULTANEOUSLY BY REMOTE SITE.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	
CSM TERMINAL PHASE FINALIZATION (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THIS IS A 54.9-SECOND RCS BURN WHICH OCCURS OVER GWM. RENDEZVOUS OCCURS IMMEDIATELY THEREAFTER OVER GWM. TRACKING FOR BURN MUST BE PROVIDED BY TAN (NOT YET USB) AND
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	

TABLE E-1 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
CSM TERMINAL PHASE FINALIZATION (RCS) (CONT'D)					
					UPDATED FROM CRO. UPDATE FROM CRO IS 10 MINUTES PRIOR TO BURN. BOTH VEHICLES ARE SUPPORTED SIMULTANEOUSLY.
CSM - OWS ORBITAL SUPPORT					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB (PM) USB (FM)	USB	VHF VOICE OF AM IS BACKUP TO CSM. AM HAS NO TRACKING. POWER COULD BE CONSERVED BY CUTTING OFF C-BAND TRACKING ON CSM.
AM	VHF (B)	N/A	VHF (PCM) VHF (DUMP)	UHF (FC)	
CSM DEORBIT MANEUVER					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THE PLANNED DEORBIT MANEUVER IS APPROXIMATELY A 28-SECOND SPS BURN. THE BURN DOES NOT OCCUR OVER A GROUND STATION AND A SHIP IS REQUIRED IF REAL-TIME SUPPORT IS REQUIRED. THE CM-SM SEPARATION OCCURS BETWEEN HAW LOS AND GDS AOS AND IS NOT SUPPORTED. IF SUPPORT IS REQUIRED, A SHIP MUST BE USED.

The USB systems from the CSM require primary support during this mission phase. Three PCM telemetry downlinks are received at the remote sites during this interval. If the M&SS were active, all PCM downlinks could not be supported. This is within the capability of the remote site to process in real time, if required. When the CSM/M&SS separates from the launch vehicle, these vehicles become the primary vehicles for ground support and the launch vehicle becomes secondary. (See Table E-1.)

E.3.1.4 M&SS Experiment Period

The M&SS experiment is conducted during the next 5 days of the mission. This experiment has real-time support periods as well as dumped data requirements. Since the experiment times are dependent upon lighting conditions, real-time support intervals are mission dependent. The prime source of data from this experiment will be from exposed film which will be returned to earth.

The M&SS experiment will also require attitude and position operational data from the CSM. This requirement can be satisfied by simultaneously supporting the two USB downlinks from the CSM in the real-time mode. A method of experiment start time for the analog and digital tape correlation must be provided during the active phases of the experiment.

The onboard dump situation is similar to the real-time situation. The CSM telemetry can be recorded at an input rate of 1.6 kbps and dumped at a 32:1 ratio or recorded at 51.2 kbps and dumped at 1:1. As shown in subsequent paragraphs, the dump speed for the M&SS data is limited to a 1:1 dump ratio. Thus, at the altitude involved, experiment periods exceeding approximately 5 to 6 minutes could not be dumped into a remote site. The best dump period would be during a continental United States pass when approximately 15 to 18 minutes of continuous dump support can be provided.

During the M&SS test and evaluation period, the lunar timeline of the M&SS will be simulated. This timeline will represent a high activity period for the CSM/M&SS and should be phased into the timeline such that optimum ground support for approximately 8 hours is available. This period could be best supported by initiating it during an initial United States pass.

The M&SS experiment is secured prior to AAP-2 launch.

E.3.1.4.1 M&SS Downlinked Data

The M&SS experiment and housekeeping data from the M&SS is routed through an umbilical to the CSM. The data is then either processed by the CSM to the scientific subcarriers and downlinked in real time or routed to the CSM tape recorder system for recording and playback at a later time. The scientific subcarriers are frequency modulated onto the USB (FM) downlink. Attitude data is required from the CSM for experiment purposes. During the real-time support condition, two USB downlinks must be supported simultaneously by the ground support systems.

The scientific subcarriers, although analog by design, appear to have the capability to process the PCM encoded data rate of the M&SS during the real-time situation. The dump mode of the scientific subcarriers of 32:1 would produce a data rate in excess of the capability of the scientific subcarrier as demonstrated in Table E-2.

TABLE E-2
PLAYBACK OF SCIENTIFIC SUBCARRIERS

SUBCARRIER	RT BANDWIDTH	PB RATIO	RECORD BANDWIDTH	DUMP BANDWIDTH
95 KC	0-2850 CPS	32:1	12.5-89 CPS	400-2850
125 KC	0-3750 CPS	32:1	12.5-117 CPS	400-3750
165 KC	0-4950 CPS	32:1	12.5-154 CPS	400-4950

From Table E-2, the largest bandwidth which can be recorded and dumped at the 32:1 ratio is 154 cps. Any recorded data must be played back at a ratio of 1:1 if the data is to be downlinked through the scientific subcarriers.

The onboard modes of operation of the USB FM downlink indicate that the scientific subcarriers are either in a real-time or a playback situation, but not both simultaneously. Some modification is required onboard if the experiment data is to be downlinked in real time and dumped at the same time. The lunar version of the M&SS will downlink its real-time data over one subcarrier and its dump data over a second subcarrier. This arrangement represents a mode in the CSM USB system for scientific subcarriers which is not presently available. This mode must be incorporated prior to satisfying any requirement for the CSM to dump and process real-time data through separate scientific subcarriers simultaneously.

Real-time command of the M&SS is required and will be uplinked via the CSM USB system and processed by the CSM command system to the M&SS for execution.

E.3.1.5 AAP-2 Launch

AAP-2 launch is supported by the ALDS in a manner similar to AAP-1. The orbital workshop is inserted at approximately 270 nautical miles altitude at a central angle of 24 degrees ahead of the CSM. It is assumed that the AM telemetry downlink (VHF) is not active during the launch phase, although the ALDS has the capability to support this downlink during the launch phase. The remote sites must provide to the MCC-H the necessary data for computation of the targeting updata to the CSM for rendezvous with the OWS. During this period, the CSM data is being downlinked via its USB (PM) system and the launch vehicle data is downlinked through an SIVB VHF downlink and an IU VHF downlink. The maximum loading on any one remote site is to support two real-time downlinks.

E.3.1.6 CSM Rendezvous with OWS

The present lifetime of the SIVB/IU electrical systems is 7-1/2 hours. If the CSM is to rendezvous with a stabilized and controlled OWS, the rendezvous and docking must be accomplished during this time period. The CSM accomplishes this rendezvous by performing three burns of the SPS engine.

Present mission planning places two of these burns over ground sites which do not have USB support capability. (Refer to Table E-1.) Either the third burn is not supported or a ship is required. The CSM downlinks telemetry through the USB system. Tracking for these burns can be accomplished by either the USB or C-Band ground systems. However, command to the CSM must be accomplished through a USB two-way phase locked circuit.

Terminal phase ignition is accomplished by the RCS propulsion system and, under present mission rules, does not require ground support. Prior to the first SPS burn and between each SPS burn, it may be necessary to update the targeting data in the CSM from the MCC-H computers. This command must be uplinked and verified through a site having USB capability, and this requirement is met in present mission planning.

Prior to docking the M&SS with the OWS, the ground support systems will command the OWS through a series of onboard tests to evaluate the systems status in the OWS. The AM command receiver must be on during launch to accomplish this function. The commands are uplinked through a remote site having a UHF command capability. The AM command system is similar to the Gemini command system and has a capability of 32 real-time commands. When the AM systems are verified as satisfactory by the ground support systems, the CSM soft docks the M&SS to the MDA. The softdocking occurs within the lifetime of the SIVB/IU electrical system. After softdocking the M&SS to the MDA, an EVA is performed to accomplish the following:

- Disconnect the M&SS-CSM umbilical
- Recover the M&SS data packages.

It is noted that an EVA maneuver was not planned after M&SS extraction to connect the electrical umbilical.

This operational EVA is supported by the CSM. The EVA telemetry data is processed by the CSM by modulating the USB voice subcarrier from 4 to 14.5 kilocycles. This data can be either recorded by the CSM for dump at a later time or transmitted in real time. Two crewmen may be required to perform an EVA simultaneously. The CSM can process or record only one set of EVA data at one time. The two EVA's will, therefore, time share the biomedical and voice link to the CSM. Since the EMU transmission frequencies for the two EVA's are identical, the crew member in the CSM must carefully coordinate the voice and telemetry transmissions from the two EVA's to avoid loss of data and voice. The telemetry data from an EVA should also be identified as to which astronaut is being downlinked to simplify ground support. Voice comment by the CSM crew member should surface for this function since voice is downlinked or recorded simultaneously with the EVA data.

The CSM undocks from the M&SS and maneuvers to the opposite radial docking port where it soft docks with the MDA. The hard-dock of the CSM is performed under EVA conditions. The crew also enters the MDA and secures the M&SS latches to ensure hard docking. Final docking of the CSM occurs 14-1/2 hours after AAP-2 liftoff. This is incompatible with the SIVB/IU lifetime.

Days 7 through 13 of the mission are used by the crew to activate the orbital workshop and to evaluate its habitability. Experiment M487, crew quarters habitability, will be performed in conjunction with M402, the OWS. The telemetry data associated with activating and checking out the OWS to determine its habitability is considered operational data for real-time purposes. All other experiments to be performed by the crew will be performed in days 15 through 25. Two operational downlinks require support during this period as given in Table E-1. The USB (FM) may also be used to dump recorded data during this interval as well as VHF dump from the AM telemetry system. Commands will be processed to the AM through a UHF command system and to the CSM via the USB system. Day 14 of the mission is set aside for rest and relaxation of the crew, and only the minimum of housekeeping data will be processed.

E.3.1.7 CSM Deorbit Maneuver

The preliminary mission planning uses the SPS engine for the deorbit maneuver. A retropack is also being considered for the maneuver or as backup to the SPS engine. The RCS engines are not being considered because of the impact of deorbit from this altitude with the RCS fuel budget.

The SPS deorbit maneuver is a major burn of approximately 28 seconds. The maneuver is presently planned to occur between HAW and CRO and will target toward an Atlantic recovery zone. Separation of the CSM and SM occurs between HAW and GDS. Two ships would be required to support these maneuvers as they do not occur over MSFN ground stations. The entry interface occurs over GYM and WHS. Splashdown occurs in the Atlantic Recovery Area.

E.3.1.8 Proposed Series A Mission Experiments

Days 15 through 25 of the mission will be devoted to performing the OWS experiments. The operational downlinks will also require closer observation by the ground support systems since 14 days was the initial design requirement for the CSM systems. The experiments to be performed during this period are given as follows:

D012	Astronaut Maneuvering Unit
D017	CO ₂ Reduction
D018	Integrated Maintenance
D019	Suit Donning and Sleep Station Evaluation
D020	Evaluation of Alternate Restraints for Mobility and Maintenance
D021	Expandable Airlock Technology
D022	Expandable Structures for Recovery

M050 Metabolic Cost of Inflight Tasks

M051 Cardiovascular Functions

M052 Bone and Muscle Changes

M053 Human Vestibular Functions

M054 Neurological Study

M055 Time and Motion Study

M402 Orbital Workshop

M466 Space Suits and Lunar Surface Experiments
Hardware

M469 ST-124 Removal and Disassembly

M479 Zero "G" Gravity Flammability

M486 Astronaut EVA Activities

M487 Crew Quarters Habitability

M488 High Pressure Gas Expulsion

M489 Heat Exchange Service

M492 Tube Joining In Space

M493 Electron Beam Welding

T002 Manual Navigational Sighting

T003 Inflight Nephelometer

T017 Meteoroid Impact and Erosion

T020 Jet Shoes

T021	Meteoroid Velocity
T023	Surface Adsorbed Materials
S009	Nuclear Emulsion
S063	UV Airglow Horizon Photography

E.3.1.9 Experiments Time Analysis

The preliminary crew timeline makes the following crew time allocations for the 11-day experimental period. All other time is allocated for housekeeping.

- 5 hours with 3 men awake (1 man in CSM)
- 6 hours with 2 men awake (1 man asleep in CSM)
- 4 hours with 1 man awake (2 men asleep in CSM)

Therefore, the total time per day for two-man experiments is 11 hours per day or 121 hours for the total mission. Table E-3 shows 300 hours is required to perform the experiments requiring two men while only 121 two-man hours are available. The experiment performance and crew availability times are not compatible. Experiment D018 consumes 102 hours of two-man crew time because it is performed twice.

The experiments M488, M489, and 492 are performed in the OWS area. Although these experiments require only a single crew member for performance, it is unlikely that a single crew member will be in this area while the other astronauts are asleep. It is probable that these experiments will have to be integrated into the two-man experiment time period and bring the two-man total to 314.5 hours. (See Table E-4.)

Experiment T002 requires three-man support, one of which is in the CSM. This also impacts the two-man availability and brings the total to 317.5 hours.

It is pointed out that experiments S063 and D021 do not have performance time requirements available.

TABLE E-3
EXPERIMENTS REQUIRING TWO CREW MEMBERS

EXPERIMENT	SET UP TIME	EXPERIMENT TIME	TEAR DOWN TIME
D012	3.0	1.0	2.0
D017	N/A	6.0	N/A
D018 ³	6.0	48.0	
D019	2.0	6.0	2.0
D020	1.0	12.0	1.0
D021	1.0	7.0	
D022	DATA NOT AVAILABLE		
M050 ⁴	3.5	2.5	
M051	0.2	0.6	0.2
M053 ⁵		2.0	
M054 ⁶		8.0	
M466 ⁷	1.0	1.0	1.0
M479	2.8	5.4	2.8
M469	3.5	2.5	1.5
M486 ⁸		3.0	
M487	PERFORMED IN ACTIVATING OWS		
T017	3.0	1.0	1.0
T020	1.0	4.0	1.0
T023	3.0	1.0	1.0
S009	3.0	1.0	1.0
S063	DATA NOT AVAILABLE		

TABLE E-3 (CONT'D)

NOTES:

¹3 hours allocated for EVA preparation in set up time for M469, M493, T017, T021, T023, S009, D021.

²All time in hours.

³D018 performed two times. Total time is 102 hours.

⁴M050 performed three times for each astronaut for a total of 26.0 hours.

⁵M053 performed five times for each astronaut for a total of 30 hours.

⁶M054 performed during sleep cycle of one astronaut.

⁷M466 performed four times for total of 16 hours.

⁸M486 performed twice daily for 3 hours per session on 6 days.

TABLE E-4
EXPERIMENTS FOR ONE-MAN ATTENDANCE

EXPERIMENT	SET UP TIME	EXPERIMENT TIME	TEAR DOWN TIME
D017	N/A	6 HOURS	N/A
M054	N/A	8 HOURS	N/A
M488	N/A	8 HOURS	N/A
M489	2.5 HOURS	4.0	1.5
M492	0.4	1.0	0.4
T003		14 DAYS 5 MINUTES/DAY	

E.3.1.10 Special Experiments Support

E.3.1.10.1 Experiment D012: Astronaut Maneuvering Unit

This experiment is to be performed external to the AM under EVA conditions. An umbilical cord will exist between the crew member and the airlock for processing biomedical data (one EKG channel of analog data) and voice to the AM for processing.

The voice can be downlinked through the CSM USB system, or by manual selection, through the AM VHF downlink. The biomedical data is downlinked through the operational downlink of the AM. The voice and biomedical data are operational as well as experimental.

The experiment period consists of 40 minutes of maneuvers using the unit. These maneuvers are recorded on color film, and the film is returned to earth for evaluation.

Two methods of processing the experiment data from the AMU are presently proposed.

- A. Under the first method, the AMU has a self-contained recorder to record all necessary data. The data tape is returned to earth for evaluation.
- B. Under the second method, the backpack uses a telemetry transmitter to transmit data to the space vehicles when it is within 20 feet of the vehicle. The following considerations are given.
 1. EVA exit is from AM and the umbilical is only 25 feet long.
 2. The AM is not configured to receive this data.
 3. The CSM can receive this data if the following requirements are met:
 - The AMU transmitter is designed to operate on a frequency of 257.9 MHz.

- The AMU transmitter is designed to amplitude modulate the PCM telemetry stream.
- The VHF receiver onboard the CSM has adequate bandwidth to receive the 5.12 kbps. (This value is 3.2 times the normal received telemetry rate of the LM, 1.6 kbps.)
- The CSM analog channels in the onboard tape recorder heads need to be examined to determine if they can record this rate and then dump this rate at 32:1.

Additional restrictions could also apply. If the data rate can be recorded by the analog channels of the CSM, it will probably have to be played back at a 1:1 dump ratio into the CSM USB (FM) dump transmitter baseband. For a 40-minute experiment time, the dump would have to occur over several revolutions over many MSFN sites making final data correlation difficult. Although this is not a restriction, a special RSDP program with input output formats would be required when the RSDP is already burdened with too many separate programs.

Since the experiment does not express a desire for real-time support, the self-contained telemetry recorder within the AMU appears to be the most reasonable approach from a data management point of view.

E.3.1.10.2 Experiment D017: CO₂ Reduction

This experiment is to provide data to evaluate one technique for reducing carbon dioxide within a spacecraft. The experiment is located in the CSM. Continuous data monitoring is desired either by ground support or by display to the crew members. The data is displayed to the crew through seven meters. When the experiment cannot be supported in real time, it is desired that the experiment data be recorded by the CSM and dumped at an opportune time. Crew voice and log are desired for the experiment. The data will be downlinked through the CSM operational telemetry downlink. Recorded telemetry data and voice will be dumped through the USB

(FM) downlink. This experiment expresses a real-time support requirement. One crew member is required for 4 to 6 continuous hours to operate the experiment.

E.3.1.10.3 Experiment D018: Integrated Maintenance

This experiment is performed to observe the ability of the astronauts to perform maintenance in space. The data requirements for the experiment are voice comments, photographs, and movies. A tape recorder for telemetry is provided with the experiments package. The voice tape is returned to the ground for analysis. This experiment does not require downlinked telemetry data.

The major factor concerning this experiment is the time required to perform the experiment by two crew members. The time estimate contains 6 hours of setup time and 48 hours of experiment time. In addition, it is desired that the experiment be performed at least two times. Ground support for this experiment consists of voice support only. This experiment greatly impacts the overall crew availability.

E.3.1.10.4 Experiment M051: Cardiovascular Function

This experiment is performed in the OWS. The data is taped, and the tape returned to earth for evaluation. The only support required of the MSFN is voice.

The experiment timeline requires that the experiment be initiated at 192 hours +48 hours. The experiment is repeated each 72 hours for each astronaut. The start time of this experiment is incompatible with the crew and operational timeline. The latest possible start time is 11 days into AAP-1 during the period of OWS activation and habitability evaluation. The experiment would have to be delayed until at least 360 hours, or day 15.

E.3.1.10.5 Experiment M054: Neurological Study

This experiment is performed in the CSM. Existing experiment time desires are that the experiment be performed continuously on one crew member from launch through two revolutions,

then during a sleep cycle, and two revolutions prior to reentry. The desire to perform the experiment during the first and last two revolutions of the mission is not compatible with the crew requirements not to perform experiments during this time period.

E.3.1.10.6 Experiment M469: ST124 Removal and Disassembly

Part of this experiment is performed in the impressurized IU under EVA conditions. A connection is required in the IU for the astronaut umbilical. This connection, as do those in the OWS and MDA, must be either interfaced into the AM telemetry system or the CSM system.

E.3.1.11 OWS Voice Support

Refer to Table F-1 for the specific data information necessary for ground support of the OWS experiments. As shown by this table, many of the OWS experiments desire recorded voice during experiment activity periods. The existing plan for the OWS voice system has the following capability.

The primary mode of voice communications is by hardline into the CSM where the data can be either recorded or processed via the USB or VHF voice downlinks. This hardline capability exists in the AM, SIVB workshop, EVA, and LM/ATM. This voice system can be manually switched so that the SIVB workshop, AM, and LM/ATM voice can be routed through the AM VHF voice downlink.

Experiments which require recorded voice to be dumped should be processed to the CSM for recording since the voice recorder in the airlock does not have a dump capability. This dump capability in the AM could prove beneficial in a contingency situation.

E.3.1.12 Proposed AM Recording Systems

- A. Telemetry Recorder. The operational telemetry recorder in the airlock telemetry system (Gemini type) records the prime subframe of the telemetry system. The input

data rate to the recorder is 5.12 kbps and this data is dumped at a ratio of 22 to 1. The total operational data (housekeeping) in the existing telemetry formats for the airlock is 4.036 kbps. The housekeeping data rate practically absorbs the capability of the telemetry tape recorder. Any additional experiments data from the AM could not be recorded unless it appeared on the prime subframe and had a data rate of less than 1164 bps.

It appears, therefore, that a second telemetry recorder is required onboard the AM to record experiment telemetry functions. This is especially true if the M&SS and SO17 experiments are integrated into the AM telemetry system. This recorder should be interfaced to record a subframe at 5.12 kbps. The two records should be integrated so that they record the subframes simultaneously but dump at separate times into the transmitter by ground command.

- B. Voice Recorder. The proposed voice recorder is a Gemini type recorder without dump capability. This recorder should be upgraded with dump capability or replaced with one with dump capability for the following reasons:
1. The AM voice downlink backs up the CSM primary downlink and record capability is therefore required.
 2. Many of the experiments require crew comment and voice for performance in the OWS area. Voice record is therefore required.
- C. Biomedical Tape Recorder. This Gemini type tape recorder records analog signals and has no dump capability. The biomedical data from the AM is available only in the operational real-time telemetry downlink and is not recorded by the operational tape recorder. If it is desired to record and dump the biomedical data from the AM, provisions must be made to record

this data from the subframe of the operational telemetry. Unless the CSM sampling rates are used, this could not be accomplished with one Gemini type recorder. Using the CSM sampling rates will allow a Gemini recorder to record one astronaut's biomedical data. (See Appendix D.) The requirement to dump operational biomedical data would require a separate operational tape recorder for each crew member. The recorder would have to be integrated into the data dump system to time share the dump downlink.

E.3.1.13 Passive Orbital Workshop Support

After CSM reentry and recovery, the OWS still requires periodic support. The presently stated support requirements are given as follows, using the AAP-1 splashdown as reference:

- Splashdown to plus 1 week - one site per revolution
- 1 week to 2 weeks - one site per day for two revolutions
- 2 weeks to 5 months and 2 weeks - one site per week for two revolutions
- ● 5 months and 2 weeks to 5 months and 3 weeks - one site per day for two revolutions
- 5 months and 3 weeks to AAP-3 launch - one site per revolution.

A series of ground commands will be used to evaluate the status of the OWS. A UHF command system is required at the ground station for OWS support. These requirements can be met by the MSFN ground stations except for the requirement for one site support per revolution.

The OWS is launched on an 83-degree launch azimuth. With the launch revolution taken as Revolution 1, the following analysis applies:

- Adequate ground support exists for the first seven revolutions

- Revolution 8 has marginal pass (less than 3 minutes above 5 degrees) for ACN and an adequate pass for GWM. Neither of these sites have UHF command capability.
- Revolutions 9 and 10 have ground support from GWM and ACN, however, these sites cannot command the AM systems
- Revolution 11 has a marginal pass for CYI
- Revolutions 12 through 15 are adequately supported.

The requirement for support for each revolution cannot be provided by the MSFN ground stations. Several alternatives exist to this support consideration.

- A. Position an Apollo ship with UHF command capability for support of Revolution 8. Command all AM systems on with this ship on the Revolution 8 and leave these systems on until the 12th revolution support from CYI. Position a second Apollo ship to support Revolution 11. This method has the advantage of meeting the requirement, however, it has two disadvantages.
 - 1. Scheduling two Apollo ships in the multimission support configuration to remain in one location for one week will be difficult.
 - 2. Leaving the complete AM system on may impact the AM power budget.
- B. Command all AM systems on at HAW during the 7th revolution and use the existing ground stations in the MSFN to support the mission. This alternative does not meet the requirement as follows:
 - 1. The AM is not supported from GWM on Revolution 10 to CYI on the 12th revolution, a time period of 2 hours and 25 minutes. (CYI has a marginal pass on Revolution 11.) This interval is only 55 minutes longer than the normal requirement once each day.

2. Leaving the complete AM system on may impact the power budget to an even greater degree (6 hours, 50 minutes total time).

C. Relax the support requirement during this time interval.

Of the three possibilities discussed, using the MSFN sites and turning on the AM for 6 hours 50 minutes is the better solution if the AM power budget is flexible. This method would release the ships for other multimission support which may be more critical and would closely approximate meeting the requirement.

E.3.2 Series B Missions

The series B missions consist of the launch of AAP-3 on day 1. (This occurs approximately 5 months after recovery of the CM from AAP-1.) The manned CSM of AAP-3 is inserted into an elliptical orbit with a perigee of 85 nautical miles and an apogee of 115 nautical miles. After separation from the launch vehicle, the SPS engine is ignited to circularize the CSM orbit at 115 nautical miles.

At approximately 23 hours and 30 minutes, the AAP-4 with its unmanned LM/ATM payload is launched into a circular 240 nautical mile orbit. Through a series of SPS and RCS engine burns, the CSM rendezvous and docks with LM/ATM and extracts it from the launch vehicle during the 7-1/2 hour lifetime of the launch vehicle. The SPS engine is then ignited to perform a docked phase maneuver with the AAP-2 (OWS) orbiting vehicle.

The rendezvous sequence between AAP-3/AAP-4 and AAP-2 consists of two SPS engine burns to reach a docked equal period maneuver. The LM is then manned and performs the coelliptical and terminal phase initiation maneuvers with the LM RCS engines. The braking maneuvers of the LM/ATM also use the LM RCS engines. During the LM/ATM active rendezvous, the CSM remains in an equal period orbit with the OWS. The LM/ATM also remains within rescue capability of the CSM.

After LM/ATM rendezvous is complete, the CSM performs the same rendezvous sequence. The vehicles then dock with the OWS MDA,

the LM/ATM on a radial port and the CSM on the axial port. This rendezvous sequence between the three missions consumes approximately 3 days of mission time. (Although this is not considered in the analysis, there may not be an active stabilization system on the OWS for this rendezvous sequence.)

The next 52 days of the mission are devoted to accomplishing the mission and experiment objectives. Approximately 40 days exist during this period for performing the experiments.

On the 55th day of the mission, the OWS/LM/ATM are placed in a passive mode and stored in orbit.

The 56th day of the mission consists of the CSM SPS burn to deorbit and reentry and recovery of the command module.

E.3.2.1 AAP-3 Launch

The ALDS is called up to support the launch of AAP-3. (See Table E-5.) The downlinks requiring support are identical to those of AAP-1. The support of launch will be similar to AAP-1 except that the payload of the AAP-3 launch vehicle is a manned CSM only. The CSM is inserted into an 80 by 115 nautical mile elliptical orbit with planned phasing with the OWS trajectory. During the 6-month period since the initial launch of the OWS into a 270 nautical mile circular orbit, the orbit has decayed to an altitude of approximately 260 nautical miles.

E.3.2.2 Circularization Burn

Approximately 2 hours 25 minutes after liftoff, the SPS engine of the CSM is ignited to perform a circularization burn. This burn represents a high activity period for the CSM. At least one tracking pass of 4 minutes will be required 1 hour prior to the burn, and the CSM must be updated with targeting data prior to the burn. These functions can be performed during the first revolution since a United States pass is part of the trajectory during this period. The CSM update is accomplished via an USB command system. Preliminary planning for burn support uses CRO as the support site.

E.3.2.3 AAP-4 Launch

Approximately 23 hours 30 minutes after AAP-3 liftoff, AAP-4 is launched from launch complex 37B. The ALDS is called up to support the AAP-3 launch. The payload of the launch vehicle is an unmanned Lunar Module with an attached ATM rack. It is assumed that the LM/ATM is not radiating during the launch phase of AAP-4, and these downlinks are not activated until the LM is manned prior to the final rendezvous sequence. The ALDS has sufficient ground support capability to support these downlinks, however, a separate set of antennas would be required since the LM/ATM antennas are shielded by the SLA.

E.3.2.4 CSM Rendezvous Docking and Extraction of the LM/ATM

This rendezvous is accomplished within the prescribed lifetime of the launch vehicle (7-1/2 hours). The preliminary analysis of this rendezvous technique by responsible NASA offices uses the following maneuvers to accomplish the rendezvous.

<u>MANEUVER</u>	<u>ENGINE USED</u>
CSM Phasing Maneuver	SPS
CSM Height Maneuver	SPS
CSM Coelliptical Maneuver	SPS
CSM Terminal Phase Initiation	RCS
CSM Braking Maneuver	RCS
CSM Soft Dock	
CSM Hard Dock	
LM/ATM Extraction by CSM	

Table E-5 summerizes the ground support as configured in the preliminary analysis. As shown in this table, all maneuvers are supported by ground stations except CSM terminal phase initiation. If this event requires support, a ship must be placed off

the west coast of Africa. This maneuver is an RCS engine maneuver. Adequate sites were available in the support configuration to allow for high-speed tracking and update prior to the next maneuver. In the case of the CSM height maneuver, it will be necessary to high-speed track at ANT during and after the SPS burn and then update at ACN immediately thereafter for the next maneuver.

It is assumed that the SIVB will vent the LOX tanks immediately after insertion and leave the vents in the open position since restart of the SIVB engine is not required.

E.3.2.5 CSM/LM/ATM Rendezvous with AAP-2

This phase of the mission is accomplished with the following maneuvers :

<u>MANEUVER</u>	<u>ENGINE USED</u>
Docked Phase Maneuver	SPS
Docked Height Maneuver	SPS
Docked Equal Period Maneuver	SPS
LM/ATM Coelliptical Maneuver	LM RSC
LM/ATM Terminal Phase Initiation	LM RCS
LM/ATM Braking Maneuver	LM RCS
CSM Coelliptical Maneuver	CSM RCS
CSM Terminal Phase Initiation	CSM RCS
CSM Braking Maneuver	CSM RCS
LM/ATM Docking	
CSM Docking	

Table E-5 shows the preliminary trajectory analysis in which each of the SPS engine burns is supported by a ground station except the docked phase maneuver. If it is desired to support this maneuver, a ship must be located west of HAW.

Terminal phase ignition occurs over PRE for both vehicles. This is an RCS engine burn.

Rapid trajectory and updata by the ground support systems is necessary between the coelliptical maneuver and terminal phase ignition for each vehicle. However, the coelliptical maneuvers occur over the United States and sufficient ground support sites are available for this purpose.

The orbital ground support of the cluster configuration (AAP-2/AAP-3/AAP-4 payloads docked) is discussed under experiments and Appendix D.

E.3.2.6 CSM Deorbit Maneuver

This maneuver is similar to the maneuver for the AAP-1 CSM shown in Paragraph E.3.1.6. The SPS engine burn will probably be of slightly less duration because of the loss in altitude of the OWS.

E.3.2.7 Series B Mission Experiments

The following experiments are scheduled to be performed on the AAP-3 and AAP-4 missions.

- * M050 Metabolic Cost of Inflight Tasks
- * M051 Cardiovascular Function
- * M052 Bone and Muscle Changes
- * M053 Human Vestibular Function

* Experiments are performed on series A missions and must be resupplied on series B missions.

TABLE E-5
SUPPORT OF SERIES A MISSION EVENTS

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
AAP-3 LAUNCH					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	LAUNCH IS SUPPORTED BY THE ALDS SYSTEM. SUPPORTING SITES ARE KSC GBM, BDA AND ANT. P = PRIMARY DOWNLINK B = BACKUP DOWNLINK FC = FLIGHT CONTROL RSO = RANGE SAFETY OFFICER
SIVB/IU	N/A	C-BAND	2 VHF (PCM) 2 VHF (PAM)	UHF/SIVB (RSO) UHF/IU (FC)	
SIB	N/A	N/A	VHF (PCM) VHF (PAM)	UHF (RSO)	
CSM CIRCULARIZATION BURN (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THIS SPS ENGINE BURN OCCURS OVER CRO DURING THE SECOND REVOLUTION. TRACKING PRIOR TO THIS BURN CAN BE ACCOMPLISHED BY CRO OR DURING THE U.S. PASS ON THE FIRST REVOLUTION. ANY UPDATE REQUIRED CAN BE ACCOMPLISHED DURING THE U.S. PASS, PREFERABLY AT KSC.
ORBITAL COAST PERIOD					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	TRAJECTORY OF THE CSM IS ESTABLISHED BY MSFN SITES DURING THIS 20-HOUR PERIOD. CSM RENDEZVOUS RELATIONSHIP WITH OWS IS ALSO ESTABLISHED. HOUSE-KEEPING AND SLEEP FOR CREW.

TABLE E-5 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
AAP-4 LAUNCH					
SIVB/IU	N/A	C-BAND	2 VHF (PCM) 2 VHF (PAM)	UHF (RSO) (FC)	AAP-4 LAUNCH IS SUPPORTED BY ALDS SITES BDA, ANT AND KSC. THE CSM IS TRAILING BY SOME CENTRAL ANGLE AND IS NOT SUPPORTED SIMULTANEOUSLY BY ALDS. AAP-4 IS INSERTED INTO A 240 NAUTICAL MILE CIRCULAR ORBIT. CSM IS IN A 115 NAUTICAL MILE CIRCULAR ORBIT.
SIB	N/A	N/A	VHF (PCM) VHF (PAM)	UHF (RSO)	
CSM	USB (P) VHF (B)	USB (P) VHF (B)	USB	USB	
CSM PHASING MANEUVER (SPS)					
CSM	USB (P) VHF (B)	USB (P) VHF (B)	USB	USB	THE TRAJECTORY OF THE AAP-4 MUST BE IMMEDIATELY DETERMINED IN ORDER TO ESTABLISH THE PARAMETERS FOR THE CSM PHASING MANEUVER. CYI HAS APPROXIMATELY A 4-MINUTE PASS TO COLLECT THIS DATA AND ROUTE TO MCC-H FOR COMPUTATION AND UPDATE OF THE CSM IF REQUIRED. THIS UPDATE COULD THEN BE ACCOMPLISHED AT KSC, BDA, OR CYI. THE PHASING MANEUVER IS SUPPORTED BY CRO. SUPPORT OF CSM AND SIVB/IU NOT SIMULTANEOUS AT A SITE.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	
CSM HEIGHT ADJUSTMENT (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	CSM AND SIVB/IU SUPPORT NOT SIMULTANEOUS AT A SITE. TRACKING PRIOR TO BURN PROVIDED BY GYM. UPDATE FROM TEX. SPS BURN SUPPORTED BY KSC AND GBM.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)		

TABLE E-5 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
CSM COELLIPTICAL MANEUVER (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	CSM AND SIVB/IU NOT SUPPORTED SIMULTANEOUSLY BY SITE. THIS SPS BURN SUPPORTED BY CRO. TRACKING PRIOR TO BURN FROM ACN AND BDA. UPDATE ACCOMPLISHED, IF REQUIRED, FROM TAN (IF TAN IMPLEMENTED WITH USB)
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	
CSM TERMINAL PHASE INITIATION (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	CSM AND SIVB/IU NOT SUPPORTED SIMULTANEOUSLY BY SITE. TRACKING AND UPDATE, OF CSM (IF REQUIRED) PROVIDED BY HAW, GYM, TEX, KSC, BDA, ACN. THIS IS AN RCS BURN WHICH OCCURS OFF THE COAST OF AFRICA. IF REAL-TIME SUPPORT IS DESIRED, A SHIP WOULD BE NECESSARY.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	
CSM BRAKING MANEUVER (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	CSM AND SIVB/IU SUPPORTED SIMULTANEOUSLY. BRAKING MANEUVER ACCOMPLISHED WITH RCS ENGINES. SUPPORT FOR MANEUVER PROVIDED BY CRO. CSM NOW IN A 240 NAUTICAL MILE CIRCULAR ORBIT.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	

TABLE E-5 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
CSM DOCK WITH AAP-4 (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	SIMULTANEOUS SUPPORT OF BOTH VEHICLES. GWM AND HAW SUPPORT VEHICLES DURING CLOSURE. SOFT-DOCKING OCCURS OVER GYM AND GDS. TEX, KSC, GBM, AND ANT SUPPORT HARDDOCKING PROCEDURE WITH FINAL HARDDOCKING OCCURING OVER ACN.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	
LM/ATM EXTRACTION (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	GWM PROVIDES SUPPORT PRIOR TO EXTRACTION. (GWM HAS NO UHF CMD CAPABILITY.) EXTRACTION OCCURS OVER THE HAW SITE. EXTRACTION COMPLETE IN APPROXIMATELY 6 HOURS 10 MINUTES AND IS WITHIN LIFETIME OF IU.
SIVB/IU	N/A	C-BAND	2 VHF (PCM)	UHF (FC)	
CSM DOCKED PHASE MANEUVER (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	LM/ATM ASSUMED INACTIVE. THIS IS A MAJOR SPS ENGINE BURN AND IT OCCURS APPROXIMATELY 2 HOURS 40 MINUTES AFTER EXTRACTION. THREE SITES CAN SUPPORT THE CSM DURING THIS TIME INTERVAL: GYM, GDS, GWM. UPDATE AND TRACKING MUST BE ACCOMPLISHED FROM THESE SITES. THE BURN IS NOT SUPPORTED BY A LAND SITE. HAW AOS OCCURS APPROXIMATELY 15 MINUTES AFTER THE BURN. A SHIP COULD BE USED TO SUPPORT THE BURN IN REAL-TIME IF REQUIRED.

TABLE E-5 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
DOCKED HEIGHT MANEUVER (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THIS MANEUVER PERFORMED OVER CNB. THIS IS AN SPS ENGINE BURN. TRACKING AND UPDATE FOR THE BURN CAN BE PROVIDED BY U.S. SITES. THIS EVENT BEGINS THE THIRD DAY OF ACTIVITIES.
DOCKED EQUAL PERIOD MANEUVER (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	MANEUVER OCCURS OVER GTI WITH SUPPORT FROM GBM AND ANT. LM/ATM/CSM PLACED IN EQUAL PERIOD WITH OWS. LM IS MANNED, ACTIVATED AND CHECKED OUT AFTER THIS EVENT.
LM/ATM COELLIPTICAL MANEUVER (LM RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	LM RCS SYSTEM USED FOR THIS MANEUVER. EVENT OCCURS OVER TEX. STATUS OF LM CMD SYSTEM NOT KNOWN, THEREFORE, UPDATE REQUIREMENT NOT KNOWN. THE TRAJECTORY IS SUCH THAT TRACKING AND AN UPDATE COULD BE ACCOMPLISHED. LM UNDOCKS FROM CSM AND PERFORMS MANEUVER. CSM REMAINS IN EQUAL PERIOD POSITION.
LM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB		

TABLE E-5 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
LM/ATM TERMINAL PHASE INITIATION (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	VEHICLES NOT SUPPORTED SIMULTANEOUSLY. LM USES RCS ENGINES FOR MANEUVER. MANEUVER ACCOMPLISHED OVER PRE.
LM/ATM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB		
LM/ATM BRAKING (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	LM AND AM SUPPORTED SIMULTANEOUSLY. AM IS CONSIDERED ACTIVE FOR THIS MANEUVER, HOWEVER, THIS MAY NOT BE THE CASE. THE OWS HAS NO STABILIZA- TION SYSTEM AT THIS TIME. LM RCS SYSTEM IS USED FOR MANEUVER. EVENT IS SUPPORTED BY GWM. GWM CANNOT SUPPORT UHF CMD.
LM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB		
AM	N/A	N/A	VHF (PCM)	UHF (FC)	
CSM COELLIPTICAL MANEUVER (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	MANEUVER OCCURS OVER TEX. LM/ATM AND AM SUPPORTED SIMULTANEOUSLY. RCS ENGINE USED FOR BURN.
LM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB		
AM	N/A	N/A	VHF (PCM)	UHF (FC)	

TABLE E-5 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
CSM TERMINAL PHASE INITIATION (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	LM/ATM AND AM SUPPORTED SIMULTANEOUSLY. CSM SUPPORTED SEPARATELY. CSM USES RCS ENGINES TO ACCOMPLISH THIS MANEUVER. EVENT IS SUPPORTED BY PRE.
LM/ATM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB		
AM	N/A	N/A	VHF (PCM)	VHF (FC)	
CSM BRAKING MANEUVERS (RCS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	ALL VEHICLES SUPPORTED SIMULTANEOUSLY. RCS ENGINES USED FOR MANEUVER. EVENT SUPPORTED BY GWM.
LM/ATM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB		
AM	N/A	N/A	VHF (PCM)	VHF (FC)	
LM/ATM AND CSM DOCKING TO OWS					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THE LM DOCKS FIRST TO THE MDA. THEN CSM DOCKS. SITE SUPPORT NOT KNOWN.
LM	USB (P) VHF (B)	USB (P) C-BAND	USB		
AM	N/A	N/A	VHF (PCM)	VHF (FC)	

TABLE E-5 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
M&SS AND OWS EXPERIMENT SUPPORT					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB (PM) (SEE REMARKS)	USB	M&SS EXPERIMENT DATA CAN BE EITHER DOWNLINKED THROUGH THE USB SCIENTIFIC SUBCARRIERS OR INTERFACED WITH THE AM AND DOWNLINKED. AM INTERFACE FREES ONE PCM GROUND STATION. CSM MUST OPERATE USB IN PM AND FM MODE IF SCIENTIFIC SUBCARRIERS USED. OWS EXPERIMENT'S DATA DOWNLINKED THROUGH AM.
AM	VHF (B)	N/A	VHF (PCM) VHF (DUMP) (IF REQUIRED)	UHF (FC)	
SO17 EXPERIMENT SUPPORT					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	EXPERIMENT SO17 PROPOSES ITS OWN TELEMETRY SYSTEM AND DOWNLINK. TO SIMPLIFY GROUND SUPPORT AND REDUCE REMOTE SITE LOADING, IT IS RECOMMENDED IN THIS ANALYSIS THAT THIS EXPERIMENT BE INTEGRATED INTO THE AM TELEMETRY DMS AND DOWNLINKED.
AM	VHF (B)	N/A	VHF (PCM)	UHF (FC)	
SO17	N/A	N/A	VHF (PCM)	N/A	
ATM EXPERIMENT SUPPORT					
CSM	USB (P) UHF (B)	USB (P) C-BAND (B)	USB (PM) USB (FM)	USB	ALL VOICE NORMALLY DOWNLINKED THROUGH CSM USB. TRACKING WILL NORMALLY BE OF CSM. ONLY FOUR PCM DOWNLINKS REQUIRE POSSIBLE REAL-TIME SUPPORT.
LM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB		
ATM	N/A	N/A	VHF (PCM) VHF (DUMP)	UHF (FC)	
AM	VHF (B)	N/A	VHF (PCM) VHF (DUMP)	UHF (FC)	

TABLE E-5 (CONT'D)

VEHICLE	VOICE	TRACKING	TELEMETRY	COMMAND	REMARKS
CSM DEORBIT MANEUVER (SPS)					
CSM	USB (P) VHF (B)	USB (P) C-BAND (B)	USB	USB	THE DEORBIT MANEUVER IS AN SPS BURN. IT IS ASSUMED THAT THIS BURN IS SIMILAR TO THE AAP-1 MANEUVER AND AS SUCH REQUIRES GROUND SUPPORT BECAUSE OF DURATION.

** M423	Hydrostatic Gas Bearing Evaluation
M439	Star Horizon Tracker
* M401	Mapping and Survey System
* M469	ST-124 Assembly and Repair
* M493	Electron Beam Welding
S015	The Influence of Zero Gravity on a Single Human Cell
S015A	Survival of Living Organisms
S017	X-Ray Astronomy
S019	UV Stellar Astronomy
** S027	X-Ray Astronomy
S061	Potato Respiration
T004	Frog Otolith
** T022	Heat Pipe Demonstration
Five ATM Experiments (S052 Through S056)	

E.3.2.8 Experiment Time Analysis

Refer to Table F-1 for the ground support requirements of the experiments proposed for this mission. Seven of the experiments presently proposed for the series B missions were performed during

* Experiments are performed on series A missions and must be resupplied on series B missions.

** Experiment is located in and supported by the SIVB/IU launch vehicle

the series A missions. The original plan was to resupply the OWS and certain experiments for use in conducting these experiments during the series B missions. However, the resupply module has been deleted from the mission requirements and the status of these experiments are not defined.

The total time required to perform all experiments other than the ATM is 114 hours. At a 100 percent utilization of the crew during the two-men awake crew period, these experiments would require approximately 11 days. (See Table E-6.)

The preliminary crew timeline allocates 40 days for experiments, thus, 29 days can be devoted to the ATM.

The times for experiments are estimated and probably are high. The typical day for the ATM in the crew timeline shows the ATM/LM is manned continuously, and 24 hours per day are available for experiment time. During the 29 days for the experiment, a total of 696 hours is available for experiments. Since some of the ATM experiments are run concurrently and the patrol mode applies to all experiments, the total experiment hours available appear to be within the timeline limits of the mission. (See Table E-7.)

E.3.2.8.1 Experiment M401: M&SS Reactivation

The requirement exists to reactivate the M&SS experiment during AAP-4. An EVA is required to reload the film in the M&SS cameras. This EVA will be supported in the normal manner of operational EVA support.

The normal data downlink for the M&SS is through the scientific subcarriers of the USB system. (See Appendix D.) However, during the cluster configuration, consideration should be given to processing this digital data from the M&SS through the AM telemetry system. Several reasons exist for this recommendation:

- A. Modifications to the AAP-3 CSM in the areas of record, and scientific subcarriers would not have to be made.
- B. The AM programmer can integrate the 8-bit encoded telemetry data into its normal output format by gating circuits. Direct integration of the experiment is also feasible.

TABLE E-6
EXPERIMENTS OTHER THAN ATM EXPERIMENTS

EXPERIMENT	SET UP TIME	EXPERIMENT TIME	TEAR DOWN TIME
M050 ¹	3.5	2.5	0.2
M051	0.2	0.6	
M053 ²		2.0	
M401 ³	6.0	20.0	
M439		2.5	
M469	3.5	2.5	
M493	2.5	4.0	
S015		2.0	
S015A		2.0	
S017		10.0	
S061	CREW TIME NOT DEFINED		1.5
T004		4.5	

¹M050 performed three times for each astronaut. Total time is 26 hours.

²M053 performed five times for each astronaut. Total time is 30 hours.

³Operational EVA required to load M&SS cameras and connect umbilical. Operational EVA required to secure film after experiment conclusion.

TABLE E-7
ATM EXPERIMENT TIME ESTIMATES

EXPERIMENT	PATROL MODE	ACTIVE MODE
S052	100 TO 300 HOURS	60 TO 100 HOURS
S053	100 TO 300 HOURS	30 HOURS
S054	100 TO 300 HOURS	98 HOURS
S055	100 TO 300 HOURS	60 TO 100 HOURS
S056	100 TO 300 HOURS	60 TO 100 HOURS

- C. The supporting ground stations do not have to tie up a PCM ground station to decommutate this low bit rate and thus site turnaround time is decreased.

An EVA is required to load film into the M&SS cameras and connect the umbilical prior to reactivation. An EVA is also required after the experiment is completed to retrieve the film from the M&SS.

E.3.2.8.2 Experiment M423: Hydrostatic Gas Bearing Evaluation;
Experiment T022: Heat Pipe Demonstration; and Experi-
ment S027: X-Ray Astronomy

These three experiments are to be performed in the IU. Preliminary assignments of these experiments place these experiments as follows:

- M423 - AAP-4
- T022 - AAP-4
- S027 - AAP-3.

The data from these experiments is downlinked through the IU telemetry system. The best approach to experiment assignment for ground support purposes would be to assign the experiments to a launch vehicle which is not involved in a real-time operational situation and least effects site turnaround. (Commands are associated with these experiments, i.e., start, dump, etc., and operational requirements might restrict these experiment command functions. In addition, the data would have to be recorded at the site and processed postpass.)

The only mission in which these criteria are met is AAP-3. The CSM separates from the launch vehicle and the launch vehicle is no longer operationally required except for experiment purposes. The CSM performs a circularization burn and increases the separation distance from the spacecraft so that the remote sites can perform operational functions and turnaround and perform experimental functions. Consideration should be given to incorporating these three experiments in the AAP-3 launch vehicle for more effective ground

support. This incorporation would have the advantage of immediate data processing by the remote site to the MCC-H if desired, since three high-speed data lines can be called up at the remote site.

The IU at the present time does not have a record nor dump capability. A recorder is proposed for this function, however.

E.3.2.8.3 Experiment S015: Influence of Zero Gravity on a Single Human Cell; and Experiment S015A: Survival of Living Organisms

These experiments are proposed for AAP-3. The only data required by the experiments is film, crew comments, and crew log. However, the experiments impact the operational timeline because they must be performed during the first 13 days of the mission.

The timeline for these experiments is incompatible with the crew and operational timeline.

E.3.2.8.4 Experiment S017: X-Ray Astronomy

This experiment proposes its own data management system and telemetry transmitter (VHF). The data rate is 1.6 kbps. (Refer to Appendix D for analysis.) The experiment is performed in the MDA. Attitude and trajectory data from the CSM is also required. Each observation is from 15 to 30 minutes, with between 10 and 20 observations required. Consideration should be given to integrating this experiment data into the AM telemetry downlink. This would present the following advantages:

- Eliminate one RF downlink from the cluster configuration
- Free one PCM ground station program for other mission support or for turnaround capability
- Reduce by one the RSDP programs
- Provide more efficient handling and processing of the experiments data by the MSFN.

E.3.2.8.5 Experiment T004: Frog Otolith

The frog otolith experiment requires that the experiment be performed 29 times during the first 36 hours of the mission. The operational timeline for AAP-3 is completely adsorbed with operational functions because of complex rendezvous and operational maneuvers. The first 6 days of the mission have been constrained from experiment use in the preliminary crew timeline. The experiment could not be integrated into AAP-1 because of these same operational requirements. It would appear that this experiment might be integrated into AAP-1, however, it would affect the mission as follows:

- Require experiment performance during operational time periods
- Delay the M&SS experiment and thus delay launch of AAP-2
- Compress the crew time availability for the OWS experiments.

This time is not adequate for the number of experiments. Other areas of concern in this experiment are given in the discussion in the following paragraphs.

E.3.2.8.5.1 Description

The purpose of experiment T004 is to record the bioelectric action potentials of the vestibular nerve in the bullfrog during conditions of weightlessness and of repeated accelerations obtained by centrifuge spinning. The experiment consists of exposing two frogs to an acceleration force of 0.3 g by rotation of the centrifuge while in the weightless environment. The data required from T004 is recorded and dumped by telemetry as convenient. The data desired is as follows:

- Frog No. 1-ECG - 15-minute analog recording, 0.1 to 100 Hz
- Frog No. 2-ECG - 15-minute analog recording

- Frog No. 1-Nerve Response - 15-minute analog recording, 10 to 500 Hz
- Frog No. 2-Nerve Response - 15-minute analog recording
- Frog Status - 15-minute voice recording audio
- Time Pulse - 1 pps.

In order to integrate this experiment data into the CSM PCM format, it is necessary to digitize it. This rate exceeds the spare channels and highest sampling rates available in the CSM as well as the total bit rate in the CSM telemetry system for experiments data.

2 parameters @ 100 Hz plus 2 parameters @ 500 Hz plus
 1 time pulse per second = 5 samples per cycle = 8 bits
 per cycle = 48,040 bps.

Integration into the CSM PCM downlink is not feasible.

This experiment when analyzed for AS-205 indicated it had its own VHF/FM telemetry system. Each of the parameters listed above were fed into VCO's and were mixed and output to an analog tape recorder or to the VHF transmitter. That transmitter was to have a bandwidth of approximately 500 kilocycles. The VCO's oscillator frequencies range from 0.73 to 27.5 kilocycles. This frequency range exceeds the frequency response of the scientific subcarriers of the CSM USB telemetry system whose responses are:

<u>SUBCARRIER</u>	<u>RESPONSE</u>
95 kilocycles	0-2850 CPS
125 kilocycles	0-3750 CPS
165 kilocycles	0-4950 CPS

Therefore, the experiment data cannot be integrated into the scientific subcarriers of the CSM.

One technique does exist whereby the experiment data might be downlinked from the CSM. The bandwidth response of the TV mode of the CSM USB (FM) downlink is DC to 500 kilocycles. The T004 data could be real-time telemetered to the remote sites in analog form. The experiment data could also be dumped in analog form through this mode of USB operation with its own tape recorder at a dump rate of 4:1.

If the data is downlinked to the MSFN sites, special demodulators are required for the nonstandard VCO frequencies. Further, there is no method of processing analog data at this rate to the MCC-H from the remote site. Ground support of this experiment as proposed is limited unless augmentation to the site occurs.

A separate VHF downlink as proposed for AS-204 could be provided but this greatly impacts the CSM design, i.e., antennas, power, and the ground support.

The method of handing the onboard data for this experiment must be determined and the operational timeline for either AAP-1 or AAP-3 changed if experiment T004 is to be a part of the first four AAP missions.

E.3.2.8.6 Apollo Telescope Mount Experiment (ATM)

Refer to Appendix D for a detailed analysis of the RF downlinks and data systems of the cluster configuration.

The ATM experiment series consists of the following experiments:

S052	White Light Coronagraph
S053	Ultraviolet Coronal Spectrograph
S054	X-Ray Spectrograph Telescope
S055	Ultraviolet Spectrometer
S056	X-Ray Telescope

These experiments have different objectives although the experiment descriptions indicate that more than one experiment could be performed simultaneously. The ATM experiments present a real-time support requirement for the MSFN.

The ATM has an independent VHF RF real-time downlink and a VHF dump transmitter. It also has a recording system with dump capability. Commands to the ATM are processed through a UHF command system.

During the ATM experiment period, at least three manned vehicles are active: CSM, LM and ATM. Since the LM/ATM are continually manned in preliminary crew timeline, the AM downlink will also be active. (The AM telemetry system supports the MDA parameters.) The MSFN remote sites (excluding BDA, ANT and GBM) do not have adequate PCM ground stations to support this situation. (See Appendix F.)

The AM system is the least critical of the systems and it can be time-shared or split site-shared with the ATM during now real-time support situations.

This experiment expresses the desire to verbally communicate directly between experimenter and the crew for experiment updating. This violates FCD normal operating procedures. A teletype system between ground and spacecraft is presently being explored for this purpose.

E.3.2.8.7 Experiment S019: UV Stellar Astronomy

This experiment is performed in the AM or MDA. The experiment data will be downlinked through the AM telemetry system. The data requirement for one channel at 10 samples per second can be processed by the CSM without difficulty. The major problem associated with this experiment is the attitude accuracy of ± 30 arc seconds for values of time that will not exceed 100 continuous seconds. This requirement appears to exceed the fine attitude hold capability of the SCS on the CSM. The SCS system has a fine attitude hold capability of 0.2 degrees per second. The experiment requires CSM attitude data as part of the total experiment data. The experiment requires approximately 40 observations at 10 minutes per

observation. A maximum of four of these sittings can be accomplished during one revolution since the observation must be made on the dark side of the earth. Thus a total of 10 revolutions are required to accomplish this experiment.

The cluster must be maneuvered to point the experiment toward the desired field. This may impact the RCS fuel budget for the CSM.

At least two crewmen are required to perform the experiment. One is in the CSM for maneuver control and recording the spacecraft attitude data. The second is performing the experiment in the MDA.

E.3.2.8.8 Experiment S061: Potato Respiration

The flight crew will initiate this experiment soon after orbit insertion. The oxygen consumption rate of a potato, as well as other required data, will be processed through the CSM data management system, recorded onboard, and periodically dumped into the ground support systems. Based on the accumulated data, it may be desirable through a voice link to the CSM to request the crew to examine the specimen, replace it, or effect container repairs. This experiment offers no support problems to the ground systems.

Astronaut participation is required for this experiment for initiation and experiment contingency. The experiment is performed throughout the flight. Although the experiment is being performed during high activity periods, it does not normally require crew attendance and, therefore, might be integrated into the mission timeline.

E.3.3 Experiments Requiring Attitude Data

The following experiments require attitude data as a part of the total experiment data:

M401	S027	S055	T002
M439	S052	S056	
S017	S053	S063	
S019	S054	S065	

Experiment S027 is performed in the IU. All other experiments require CSM attitude data.

The GET clocks of the onboard data management systems might be used to correlate the data onboard. The accuracy of the attitude data required is not specified for the experiments.

E.3.4 Operational EVA's Required for Experiment Support

The following operational EVA's are in support of experiments.

A. M401 - 3 EVA's

- One EVA is required on AAP-1 for film retrieval
- Two EVA's are required during the series B missions to reload the camera prior to experiment activation and to retrieve the film after the experiment completion.

B. S009 - 1 EVA

- An operational EVA is required to deploy the experiment.

C. D021 - 1 EVA

- An EVA is required after the expandable airlock is deployed to visually inspect the experiment package.

D. T021 - 1 EVA

- An EVA is required to retrieve the experiment plates late in the AAP-4 timeline.

E. S019 - 2 EVA's

- One EVA for experiment deployment outside of AM

- One EVA for film retrieval.

F. ATM. EVA is required to retrieve film and reload the camera each 14 days of the mission. Thus, two EVA's may be required.

E.3.5 Orbital Vehicle RF Capability

Tables E-8 and E-9 are provided as a reference to RF instrumentation for the space vehicles used in the series A and B missions of the AAP. Superimposed on these tables are the other possible RF systems which would require MSFN support in the multimission configuration.

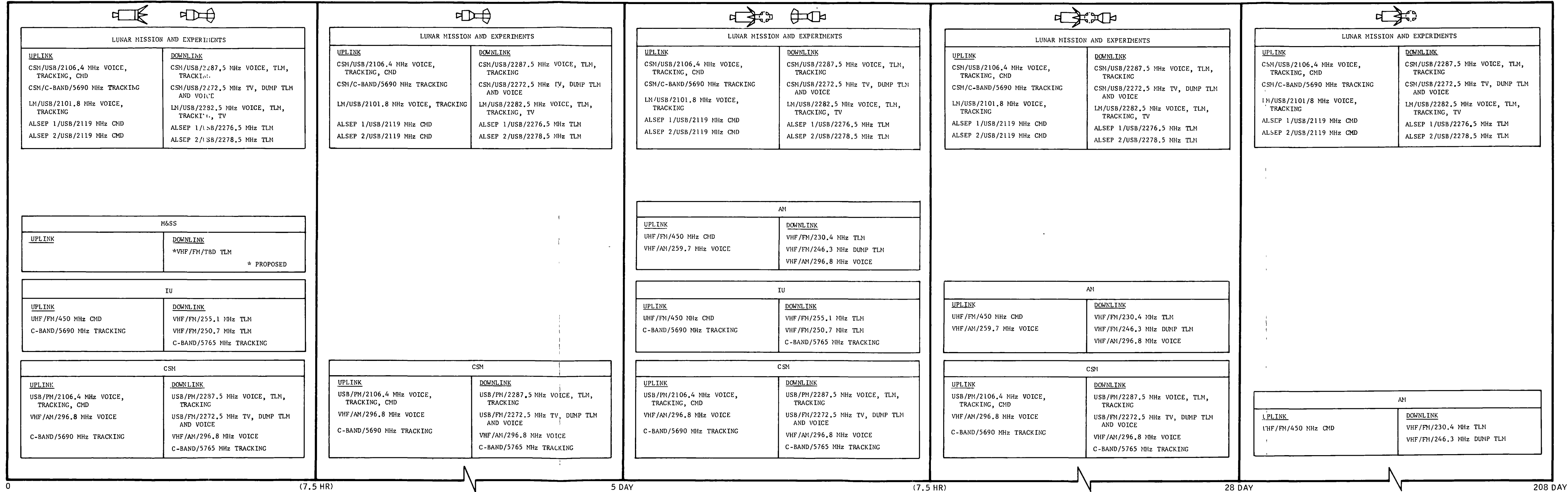


TABLE E-8
DOWNLINK SUPPORT SUMMARY
SERIES A MISSIONS

LUNAR MISSION AND EXPERIMENTS <table><tr><td><u>UPLINK</u> CSM/USB/2106.4 MHz VOICE, TRACKING, CMD CSM/C-BAND/5690 MHz TRACKING LM/USB/2101 8 MHz VOICE, TRACKING ALSEP 1/USB/2119 MHz CMD ALSEP 2/USB/2119 MHz CMD</td><td><u>DOWNLINK</u> CSM/USB/2287.5 MHz VOICE, TLM, TRACKING CSM/USB/2272.5 MHz TV, DUMP TLM AND VOICE LM/USB/2282.5 MHz VOICE, TLM, TRACKING, TV ALSEP 1/USB/2276.5 MHz TLM ALSEP 2/USB/2278.5 MHz TLM</td></tr></table>	<u>UPLINK</u> CSM/USB/2106.4 MHz VOICE, TRACKING, CMD CSM/C-BAND/5690 MHz TRACKING LM/USB/2101 8 MHz VOICE, TRACKING ALSEP 1/USB/2119 MHz CMD ALSEP 2/USB/2119 MHz CMD	<u>DOWNLINK</u> CSM/USB/2287.5 MHz VOICE, TLM, TRACKING CSM/USB/2272.5 MHz TV, DUMP TLM AND VOICE LM/USB/2282.5 MHz VOICE, TLM, TRACKING, TV ALSEP 1/USB/2276.5 MHz TLM ALSEP 2/USB/2278.5 MHz TLM	LUNAR MISSION AND EXPERIMENTS <table><tr><td><u>UPLINK</u> CSM/USB/2106.4 MHz VOICE, TRACKING, CMD CSM/C-BAND/5690 MHz TRACKING LM/USB/2101 8 MHz VOICE, TRACKING ALSEP 1/USB/2119 MHz CMD ALSEP 2/USB/2119 MHz CMD</td><td><u>DOWNLINK</u> CSM/USB/2287.5 MHz VOICE, TLM, TRACKING CSM/USB/2272.5 MHz TV, DUMP TLM AND VOICE LM/USB/2282.5 MHz VOICE, TLM, TRACKING, TV ALSEP 1/USB/2276.5 MHz TLM ALSEP 2/USB/2278.5 MHz TLM</td></tr></table>	<u>UPLINK</u> CSM/USB/2106.4 MHz VOICE, TRACKING, CMD CSM/C-BAND/5690 MHz TRACKING LM/USB/2101 8 MHz VOICE, TRACKING ALSEP 1/USB/2119 MHz CMD ALSEP 2/USB/2119 MHz CMD	<u>DOWNLINK</u> CSM/USB/2287.5 MHz VOICE, TLM, TRACKING CSM/USB/2272.5 MHz TV, DUMP TLM AND VOICE LM/USB/2282.5 MHz VOICE, TLM, TRACKING, TV ALSEP 1/USB/2276.5 MHz TLM ALSEP 2/USB/2278.5 MHz TLM
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<u>UPLINK</u> CSM/USB/2106.4 MHz VOICE, TRACKING, CMD CSM/C-BAND/5690 MHz TRACKING LM/USB/2101 8 MHz VOICE, TRACKING ALSEP 1/USB/2119 MHz CMD ALSEP 2/USB/2119 MHz CMD	<u>DOWNLINK</u> CSM/USB/2287.5 MHz VOICE, TLM, TRACKING CSM/USB/2272.5 MHz TV, DUMP TLM AND VOICE LM/USB/2282.5 MHz VOICE, TLM, TRACKING, TV ALSEP 1/USB/2276.5 MHz TLM ALSEP 2/USB/2278.5 MHz TLM				
AM <table><tr><td><u>UPLINK</u> UHF/FM/450 MHz CMD VHF/AM/259.7 MHz VOICE</td><td><u>DOWNLINK</u> VHF/FM/230.4 MHz TLM VHF/FM/246.3 MHz DUMP TLM VHF/AM/296.8 MHz VOICE</td></tr></table>	<u>UPLINK</u> UHF/FM/450 MHz CMD VHF/AM/259.7 MHz VOICE	<u>DOWNLINK</u> VHF/FM/230.4 MHz TLM VHF/FM/246.3 MHz DUMP TLM VHF/AM/296.8 MHz VOICE	AM <table><tr><td><u>UPLINK</u> UHF/FM/450 MHz CMD VHF/AM/259.7 MHz VOICE</td><td><u>DOWNLINK</u> VHF/FM/230.4 MHz TLM VHF/FM/246.3 MHz DUMP TLM VHF/AM/296.8 MHz VOICE</td></tr></table>	<u>UPLINK</u> UHF/FM/450 MHz CMD VHF/AM/259.7 MHz VOICE	<u>DOWNLINK</u> VHF/FM/230.4 MHz TLM VHF/FM/246.3 MHz DUMP TLM VHF/AM/296.8 MHz VOICE
<u>UPLINK</u> UHF/FM/450 MHz CMD VHF/AM/259.7 MHz VOICE	<u>DOWNLINK</u> VHF/FM/230.4 MHz TLM VHF/FM/246.3 MHz DUMP TLM VHF/AM/296.8 MHz VOICE				
<u>UPLINK</u> UHF/FM/450 MHz CMD VHF/AM/259.7 MHz VOICE	<u>DOWNLINK</u> VHF/FM/230.4 MHz TLM VHF/FM/246.3 MHz DUMP TLM VHF/AM/296.8 MHz VOICE				
IU <table><tr><td><u>UPLINK</u> UHF/FM/450 MHz CMD C-BAND/5690 MHz TRACKING</td><td><u>DOWNLINK</u> VHF/FM/255.1 MHz TLM VHF/FM/250.7 MHz TLM C-BAND/5765 MHz TRACKING</td></tr></table>	<u>UPLINK</u> UHF/FM/450 MHz CMD C-BAND/5690 MHz TRACKING	<u>DOWNLINK</u> VHF/FM/255.1 MHz TLM VHF/FM/250.7 MHz TLM C-BAND/5765 MHz TRACKING	CSM <table><tr><td><u>UPLINK</u> USB/PM/2106.4 MHz VOICE, TRACKING, CMD VHF/AM/296.8 MHz VOICE C-BAND/5690 MHz TRACKING</td><td><u>DOWNLINK</u> USB/PM/2287.5 MHz VOICE, TLM, TRACKING USB/FM/2272.5 MHz TV, DUMP TLM AND VOICE VHF/AM/296.8 MHz VOICE C-BAND/5765 MHz TRACKING</td></tr></table>	<u>UPLINK</u> USB/PM/2106.4 MHz VOICE, TRACKING, CMD VHF/AM/296.8 MHz VOICE C-BAND/5690 MHz TRACKING	<u>DOWNLINK</u> USB/PM/2287.5 MHz VOICE, TLM, TRACKING USB/FM/2272.5 MHz TV, DUMP TLM AND VOICE VHF/AM/296.8 MHz VOICE C-BAND/5765 MHz TRACKING
<u>UPLINK</u> UHF/FM/450 MHz CMD C-BAND/5690 MHz TRACKING	<u>DOWNLINK</u> VHF/FM/255.1 MHz TLM VHF/FM/250.7 MHz TLM C-BAND/5765 MHz TRACKING				
<u>UPLINK</u> USB/PM/2106.4 MHz VOICE, TRACKING, CMD VHF/AM/296.8 MHz VOICE C-BAND/5690 MHz TRACKING	<u>DOWNLINK</u> USB/PM/2287.5 MHz VOICE, TLM, TRACKING USB/FM/2272.5 MHz TV, DUMP TLM AND VOICE VHF/AM/296.8 MHz VOICE C-BAND/5765 MHz TRACKING				

208 DAY (7.5 HR)

 LUNAR MISSION AND EXPERIMENTS | | | |---|---| | <u>UPLINK</u>
CSM/USB/2106.4 MHz VOICE, TRACKING, CMD
CSM/C-BAND/5690 MHz TRACKING
LM/USB/2101 8 MHz VOICE, TRACKING
ALSEP 1/USB/2119 MHz CMD
ALSEP 2/USB/2119 MHz CMD | <u>DOWNLINK</u>
CSM/USB/2287.5 MHz VOICE, TLM, TRACKING
CSM/USB/2272.5 MHz TV, DUMP TLM AND VOICE
LM/USB/2282.5 MHz VOICE, TLM, TRACKING, TV
ALSEP 1/USB/2276.5 MHz TLM
ALSEP 2/USB/2278.5 MHz TLM | | ATM* | | | <u>UPLINK</u>
UHF/FM/TBD CMD | <u>DOWNLINK</u>
VHF/FM/TBD TLM
VHF/FM/TBD DUMP TLM | | LM* | | | <u>UPLINK</u>
USB/PM/2101 8 MHz VOICE, TRACKING
VHF/AM/259.7 MHz VOICE
C-BAND/5690 MHz TRACKING | <u>DOWNLINK</u>
USB/PM OR FM/2282.5 MHz VOICE, TLM, TRACKING, TV
VHF/AM/259.7 MHz VOICE
C-BAND/5765 MHz TRACKING | | AM | | | <u>UPLINK</u>
UHF/FM/450 MHz CMD
VHF/AM/259.7 MHz VOICE | <u>DOWNLINK</u>
VHF/FM/230.4 MHz TLM
VHF/FM/246.3 MHz DUMP TLM
VHF/AM/296.8 MHz VOICE | | IU | | | <u>UPLINK</u>
UHF/FM/450 MHz CMD
C-BAND/5690 MHz TRACKING | <u>DOWNLINK</u>
VHF/FM/255.1 MHz TLM
VHF/FM/250.7 MHz TLM
C-BAND/5765 MHz TRACKING | | CSM | | | <u>UPLINK</u>
USB/PM/2106.4 MHz VOICE, TRACKING, CMD
VHF/AM/296.8 MHz VOICE
C-BAND/5690 MHz TRACKING | <u>DOWNLINK</u>
USB/PM/2287.5 MHz VOICE, TLM, TRACKING
USB/FM/2272.5 MHz TV, DUMP TLM AND VOICE
VHF/AM/296.8 MHz VOICE
C-BAND/5765 MHz TRACKING | 210 DAY (7.5 HR) | LUNAR MISSION AND EXPERIMENTS | | | |---|---| | <u>UPLINK</u>
CSM/USB/2106.4 MHz VOICE, TRACKING, CMD
CSM/C-BAND/5690 MHz TRACKING
LM/USB/2101 8 MHz VOICE, TRACKING
ALSEP 1/USB/2119 MHz CMD
ALSEP 2/USB/2119 MHz CMD | <u>DOWNLINK</u>
CSM/USB/2287.5 MHz VOICE, TLM, TRACKING
CSM/USB/2272.5 MHz TV, DUMP TLM AND VOICE
LM/USB/2282.5 MHz VOICE, TLM, TRACKING, TV
ALSEP 1/USB/2276.5 MHz TLM
ALSEP 2/USB/2278.5 MHz TLM | | SO17 | | | <u>UPLINK</u> | <u>DOWNLINK</u>
*VHF/FM/TBD TLM
*PROPOSED | | ATM | | | <u>UPLINK</u>
UHF/FM/TBD CMD | <u>DOWNLINK</u>
VHF/FM/TBD TLM
VHF/FM/TBD DUMP TLM | | LM | | | <u>UPLINK</u>
USB/PM/2101 8 MHz VOICE, TRACKING
VHF/AM/259.7 MHz VOICE
C-BAND/5690 MHz TRACKING | <u>DOWNLINK</u>
USB/PM OR FM/2282.5 MHz VOICE, TLM, TRACKING, TV
VHF/AM/259.7 MHz VOICE
C-BAND/5765 MHz TRACKING | | AM | | | <u>UPLINK</u>
UHF/FM/450 MHz CMD
VHF/AM/259.7 MHz VOICE | <u>DOWNLINK</u>
VHF/FM/230.4 MHz TLM
VHF/FM/246.3 MHz DUMP TLM
VHF/AM/296.8 MHz VOICE | | CSM | | | <u>UPLINK</u>
USB/PM/2106.4 MHz VOICE, TRACKING, CMD
VHF/AM/296.8 MHz VOICE
C-BAND/5690 MHz TRACKING | <u>DOWNLINK</u>
USB/PM/2287.5 MHz VOICE, TLM, TRACKING
USB/FM/2272.5 MHz TV, DUMP TLM AND VOICE
VHF/AM/296.8 MHz VOICE
C-BAND/5765 MHz TRACKING | 264 DAY (7.5 HR) | LUNAR MISSION AND EXPERIMENTS | | | |---|---| | <u>UPLINK</u>
CSM/USB/2106.4 MHz VOICE, TRACKING, CMD
CSM/C-BAND/5690 MHz TRACKING
LM/USB/2101 8 MHz VOICE, TRACKING
ALSEP 1/USB/2119 MHz CMD
ALSEP 2/USB/2119 MHz CMD | <u>DOWNLINK</u>
CSM/USB/2287.5 MHz VOICE, TLM, TRACKING
CSM/USB/2272.5 MHz TV, DUMP TLM AND VOICE
LM/USB/2282.5 MHz VOICE, TLM, TRACKING, TV
ALSEP 1/USB/2276.5 MHz TLM
ALSEP 2/USB/2278.5 MHz TLM | | * NOT ACTIVE UNTIL EXTRACTED BY CSM | | | AM | | | <u>UPLINK</u>
UHF/FM/450 MHz CMD | <u>DOWNLINK</u>
VHF/FM/230.4 MHz TLM
VHF/FM/246.3 MHz DUMP TLM | 444 DAY |TABLE E-9
DOWNLINK SUPPORT SUMMARY
SERIES B MISSIONS

APPENDIX F
ANALYSIS OF REAL-TIME MONITOR/CONTROL REQUIREMENTS
FOR OWS EXPERIMENTS

F.1 GENERAL

The purpose of this appendix is to present the available experiments data requirements and determine their real-time support requirements. The requirements for an experiments monitor/control facility can thus be defined from this analysis of the total real-time support requirements. This experiments monitor/control facility must support the series A and B OWS missions.

F.1.1 Series A

The objectives of the series A missions are:

- A. Demonstrate and verify the operation and integrity of the M&SS in a space environment.
- B. Demonstrate the feasibility of operating OWS as a habitable space structure for up to 28 days from the AAP-1 launch date through evaluation of the CSM/SIVB/AM for the following:
 - Subsystems performance
 - Astronaut mobility and work capability in IVA and EVA
 - Use of expendables carried external to the CSM.
- C. Provide an OWS which can be stored in orbit for up to 1-1/2 years and will be capable of reactivation and rehabilitation for long duration missions anytime within that period when resupplied.
- D. Demonstrate the feasibility of a long duration manned spaceflight mission by use of expendables carried external to the CSM.

- E. Conduct medical, technological, engineering, scientific, and applications experiments in earth-orbit which will contribute to future space applications.
- F. Demonstrate the dormant capability of the spent SIVB stage and activation of the OWS as a habitable space structure.
- G. Demonstrate rendezvous of the CSM and M&SS with the OWS, and hard dock the CSM and M&SS to the docking adapter.
- H. Determine the CSM subsystems performance during spaceflight beyond 14 days duration.
- I. Verify the ability of mission ground support systems to support mission activities of extended duration involving multiple vehicles.
- J. Perform extensive IVA and EVA.
- K. Demonstrate docking of multiple vehicles to the OWS.
- L. Determine the effects on the crew of a mission duration up to 28 days.
- M. Demonstrate storage of the OWS and M&SS docked in orbit in a manner to permit revisitation and reactivation within a year.

F.1.2 Series B

The objectives of the series B missions are:

- A. Demonstrate that the orbital workshop can be reactivated after storage in orbit and can perform useful functions during an earth-orbital mission.

- B. Demonstrate that the OWS expendables can be supplied by visiting flights.
- C. Demonstrate that medical, technological, engineering, scientific and applications experiments, which will contribute to future space applications, can be conducted in earth-orbit.
- D. Demonstrate the capabilities of the ATM system.

F.2, PLANNED EXPERIMENTS

Following is a listing of proposed experiments for the AAP missions. Refer to PHO-TR285 for details of the experiments.

A. AAP-1

- *D017 - CO Reduction
- **M401 - M&SS
- *EO-OA - Metric Camera
- EO-OB - IR Images
- *EO-OD - Microwave Radiometer
- *M439 - Star Horizon Automatic Tracker
- M052 - Bone and Muscle Changes
- **M464 - Onboard Checkout System
- S005 - Synoptic Terrain Photography
- S006 - Synoptic Weather Photography
- S009 - Nuclear Emulsion
- S017 - X-Ray Astronomy (transport only)
- S018 - Micrometeoroid Collection
- S065 - Multiband Terrain Photography
- T002 - Manual Navigation Sighting
- T003 - Inflight Nephelometer

*Ground support for dumped telemetry desired.

**Ground support for real-time telemetry desired.

B. AAP-2

D012	M050	M055	M487	T003
D018	M051	M466	M488	T017
D019	M052	M469	M489	T020
D020	M053	M479	M492	T021
D022	M054	M486	M493	T023

C. AAP-3

- *M052 - Bone and Muscle Changes
- *S015 - The Influence of Zero Gravity on the Single Human Cell
- *S015A - Survival of Living Organisms
- S019 - Ultraviolet Stellar Astronomy
- ***S027 - X-Ray Astronomy
- S061 - Potato Respiration
- **S063 - Ultraviolet Airglow Horizon Photography
- T004 - Frog Otolith

- *Experiment does not require ground support.
- **Experiment performed in MDA after cluster configuration is achieved.
- ***Experiment is contained in the IU with all data downlinked by the IU.

D. AAP-4.

- **D012 - AMU
- **D018 - Integrated Maintenance
- **D019 - Suit Donning and Sleep Station Evaluation
- **D020 - Evaluation of Alternate Constraints
- **M050 - Metabolic Cost of Inflight Tasks
- **M051 - Cardiovascular Function
- **M052 - Bone and Muscle Changes
- **M053 - Human Vestibular Functions
- *M423 - Hydrostatic Gas Bearing Evaluation
- **M469 - ST-124 Assembly and Repair
- **M493 - Electron Beam Welding
- S015 - Influence of Zero Gravity on a Single Human Cell
- S015A - Survival of Living Organisms
- S017 - X-Ray Astronomy
- **S018 - Micrometeorite Collection
- S020 - Ultraviolet X-Ray Solar Photography
- *T022 - Heat Pipe Demonstration

- *Experiment performed in the IU.
- **Experiments were performed on series A missions but are resupplied and performed again on series B missions.

ATM. The following experiments comprise the ATM and will be performed on AAP-4:

- S052 - White Light Coronagraph
- S053A - Ultraviolet Coronal Spectroheliometer
- S053B - Ultraviolet Spectrographs
- S054 - X-Ray Spectrographic Telescope
- S055A - Ultraviolet Spectrometer
- S055B - Ultraviolet Spectroheliometer
- S055C - HA Telescope
- S056 - X-Ray Telescope

These planned experiments have the data support requirements as given in Table F-1. The data rates associated with this series of experiments are large when compared with the other experiment data requirements. Table F-1 also contains experiments data extracted from the most current experiments data available. Table F-2 tabulates the known real-time experiment requirements.

EXPERIMENT	TITLE	AAP FLIGHT				LOCATION PERFORMED	CREW MEMBERS REQUIRED	FLIGHT TIME	EVA REQUIRED	DATA				FILM	DISPLAY DESIRED	DATA DOWN LINK	DATA UP LINK	REMARKS		
		1	2	3	4					TELEMETRY									VOICE	
										REAL TIME	RECORDED	OPERATIONAL	DUMPED						REAL TIME	DUMPED
D012	ASTRONAUT MANEUVERING UNIT		X	X	X	EVA FROM AM	3 TOTAL 1 - CSM 1 - AM 1 - EVA	0.75 HR EVA (2 MEN) 3 HRS TOTAL	YES	NO	BIOMED DATA RECORDED BY CSM (CONTAINS ITS OWN TLM RECORDER)	NO	BY CSM	NO	YES	YES	TBD	CSM	CSM	AM CANNOT RECORD BIOMED DATA. COULD BE SCHEDULED IN CONJUNCTION WITH D021. POSSIBLE VIDEO REQUIREMENT.
D017	CO ₂ REDUCTION	X				SM	1	4-6 HR EXPECTED 2 HRS-CREW	YES	7 CHS @ .1 SPS EA.	7 CHS @ 1 SPS	NO	BY CSM	NO	1 READING EACH 2 MINS RECORDED BY CSM	NO	7 ANALOG METERS	CSM	CSM	
D018	INTEGRATED MAINTENANCE		X	X	X	OWS	2	24 HRS PER MAN	NO	NO	NDR	NO	NDR	NO	CREW COMMENTS RECORDED BY AM	YES	NONE	AM	AM	EXPERIMENTS D018, D019, AND D020 ARE GROUPED AND PERFORMED AS A COMPLEMENT TO EACH OTHER.
D019	SUIT DONNING AND SLEEP STATION EVALUATION		X		X	OWS	2	2 HRS IVA (SIVB) 8 HRS TOTAL	NO	NO	NDR	NO	NDR	NO	CREW COMMENTS RECORDED BY AM	YES	NONE	AM	AM	EXPERIMENTS D018, D019, AND D020 ARE GROUPED AND PERFORMED AS A COMPLEMENT TO EACH OTHER.
D020	EVALUATION OF ALTERNATE RESTRAINTS FOR MOBILITY AND MAINTENANCE		X		X	OWS	2	4 HRS (PART OF DATA FROM D018)	NO	NO	NDR	NO	NDR	NO	CREW COMMENTS RECORDED BY AM	YES	NONE	AM	AM	EXPERIMENTS D018, D019, AND D020 ARE GROUPED AND PERFORMED AS A COMPLEMENT TO EACH OTHER.
D021	EXPANDABLE AIRLOCK TECHNOLOGY		X			AM (EXIT TO EVA)	2	8 HRS TOTAL 2 MEN FOR A 2 HR EVA	YES	NO	4 CHS @ 1 SPS	NO	BY AM	NO	EVA RECORDED BY CSM	NO	AM PRESSURE AM INTERNAL TEMP AM EXTERNAL TEMP AM FLOW RATE	AM	AM	EXPERIMENTS D021 AND D022 HAVE COMMON EVA'S.
D022	EXPANDABLE STRUCTURES FOR RECOVERY		X			AM (EXIT TO EVA)	2	1.5 HRS EVA 7 TOTAL MAN-HOURS	YES	NO	6 CHS @ 1 SPS	NO	BY AM	NO	EVA RECORDED BY CSM	YES	FOR EXPANDABLE STRUCTURES: LEAKAGE RATE PRESSURE INTERNAL TEMP. EXTERNAL TEMP. SPACECRAFT TEMP. RADIATION LEVEL	AM	AM	EXPERIMENTS D021 AND D022 HAVE COMMON EVA'S.

TABLE F-1
EXPERIMENT SUPPORT SUMMARY (1 OF 8)

EXPERIMENT	TITLE	AAP FLIGHT				LOCATION PERFORMED	CREW MEMBERS REQUIRED	FLIGHT TIME	EVA REQUIRED	DATA								FILM	DISPLAY DESIRED	DATA DOWN LINK	DATA UP LINK	REMARKS
		1	2	3	4					TELEMETRY				VOICE								
										REAL TIME	RECORDED	OPERATIONAL	DUMPED	REAL TIME	DUMPED							
E00A	METRIC CAMERAS	X				M&SS	2	FIRST 5 DAYS	NO	NOT DEFINED	24 BILEVEL CHS @ 10 SPS	ATTITUDE	BY M&SS		RECORDED BY CSM	YES	TBD	CSM OR M&SS	CSM	PROPOSED MODIFICATION TO M&SS WILL PROVIDE DATA DUMP CAPABILITY.		
E00B	INFRARED IMAGER	X				M&SS	2	FIRST 5 DAYS	NO	NO	NDR	NO	NO		RECORDED BY CSM	YES	TBD	CSM OR M&SS	CSM			
E00D	MICROWAVE RADIOMETER	X				M&SS	2	FIRST 5 DAYS	NO	NOT DEFINED	1 CH @ 50 SPS 2 CHS @ 1 SPS	ATTITUDE	BY M&SS		RECORDED BY CSM		MULTIPLEX PARAMETERS EQUIP- MENT STATUS	CSM OR M&SS	CSM	PROPOSED MODIFICATION TO M&SS WILL PROVIDE DATA DUMP CAPABILITY.		
M018	INFLIGHT VECTORCARDIO- GRAM		X			OWS	EACH CREW MEMBER EACH DAY	2 HRS PER EX- PERIMENT	NO	NO	1 CH @ 10 Hz 1 CH @ 1 Hz 3 CHS @ 50 Hz	NO	SEE REMARKS	NO	NONE	NO	STRIP CHART OR CARDIOSCOPE	AM	AM	BIOMED RECORDER HAS NO DUMP CAPABILITY.		
M050	METABOLIC COST OF IN- FLIGHT TASKS		X		X	STORED (MDA PERFORMED OWS)	EACH CREW MEMBER WILL PERFORM THIS EXPERIMENT 3 TIMES	6 HRS TOTAL	NO	1 CHS @ .01 Hz 3 CHS @ .1 Hz 1 CH @ 2 Hz	1 CH @ .01 Hz 3 CHS @ .1 Hz 1 CH @ 2 Hz	NO	SEE REMARKS	NO	NONE	NO	O ₂ FLOW RATE CO ₂ FLOW RATE METABOLIC RATE METER	AM	AM	BIOMED RECORDER HAS NO DUMP CAPABILITY.		
M051	CARDIOVASCULAR FUNCTIONS		X		X	STORED (MDA PERFORMED OWS)	PERFORMED ON EACH CREW MEMBER EVERY 3 DAYS UP TO 4 TIMES PER MAN	2 HRS PER EX- PERIMENT	NO	NO	1 CH @ 100 Hz 3 CHS @ 10 Hz 1 CH @ 1 PPS	NO	SEE REMARKS	NO	BY AM	NO	TIMING, BLOOD PRESSURE, EKG, CIRCULATION TIME, LOWER BODY NEGATIVE PRESSURE	AM	AM	EXPERIMENTS M050 AND M052 ARE RUN IN CONJUNCTION WITH M051 FOR GROUND DATA CORRELATION (POSTFLIGHT)		
M052	BONE AND MUSCLE CHANGES		X		X	CSM AM OWS	3	0.5 HR PER DAY FOR 1 MAN	NO	NO	NDR	NO	NO	NO	NONE	NO	NONE	NO	NO			

TABLE F-1
EXPERIMENT SUPPORT SUMMARY (2 OF 8)

EXPERIMENT	TITLE	AAP FLIGHT				LOCATION PERFORMED	CREW MEMBERS REQUIRED	FLIGHT TIME	EVA REQUIRED	DATA				FILM	DISPLAY DESIRED	DATA DOWN LINK	DATA UP LINK	REMARKS		
		1	2	3	4					TELEMETRY			VOICE							
										REAL TIME	RECORDED	OPERATIONAL	DUMPED						REAL TIME	DUMPED
M053	HUMAN VESTIBULAR FUNCTIONS		X		X	STORED (MDA PERFORMED OWS)	EACH MAN ONCE EVERY OTHER DAY NOT TO EXCEED 5 TIMES	2 MANHOURS PER EXPERIMENT	NO	NO	NDR	NO	SEE REMARKS	NO	RECORDED BY AM	YES	TIME, SPIN RATE, TVTG AND OTG OUTPUT	AM	AM	BIOMED RECORDER HAS NO DUMP CAPABILITY.
M054	NEUROLOGICAL STUDY		X			STORED (MDA PERFORMED OWS)	1	1 CREW MEMBER EACH DAY	NO	NO	4 CHS @ 100 Hz 1 CHS @ 10 Hz	NO	SEE REMARKS	NO	NONE	NO	EEG, EOG IMPEDANCE PNEUMOGRAPH	AM	AM	BIOMED RECORDER HAS NO DUMP CAPABILITY.
M055	TIME AND MOTION STUDY		X			RESULTS OF OTHER EXPERIMENTS ANALYZED	2		NO	NO	NDR	NO	NO	NO	NONE	FROM OTHER EXPERIMENTS	NDR	NDR		
M401	MAPPING AND SURVEY SYSTEM	X				ATTACHED TO CSM	2	FIRST 5 DAYS	NO	POSSIBLY BUT NOT DEFINED	2 CHS @ 1 SPS	ATTITUDE	BY CSM	NO	RECORDED BY CSM	YES	UNKNOWN	CSM OR M&SS	CSM	
M402	ORBITAL WORKSHOP		X			SIVB	2	FIRST 2 DAYS	NO	TBD	SAME AS RT	YES	CSM	YES	RECORDED	NO	PRESSURE, TEMP, HUMIDITY LH ₂ TANK PASSIVATION	CSM IU	CSM	
M423	HYDROSTATIC GAS BEARING EVALUATION				X	IU	NONE	FIRST 7.5 HRS	NO	8 CHS @ 1 SPS	NO	NO	NO	NO	NO	NO	TBD	IU	NONE	IU HAS NO RECORD AND DUMP CAPABILITY.
M439	STAR HORIZON AUTOMATIC TRACKER	X				CSM	2	FIRST 5 DAYS	NO	NO	2 CHS @ 1 SPS	ATTITUDE	BY CSM	NO	RECORDED BY CSM	YES	PITCH, YAW, ROLL, PEAK PHOTOMETER READING	CSM	CSM	
M464	ONBOARD CHECKOUT SYSTEM		X			CSM M&SS CHECKOUT	1	15 MIN PRIOR TO M&SS ACTIVITY	NO	10 CHS @ 10 SPS 24 Bp SAMPLE (768 TEST POINT CHS.)	SAME AS RT	NEEDED BUT NOT DEFINED	BY CSM	NO	RECORDED BY CSM	NO	INPUT OR OUTPUT NUMERICS (DEPEND ON MODE) (15 PARAMETER TYPES)	CSM	CSM TWO 24-BIT SUB-WORDS	

TABLE F-1
EXPERIMENT SUPPORT SUMMARY (3 OF 8)

EXPERIMENT	TITLE	AAP FLIGHT				LOCATION PERFORMED	CREW MEMBERS REQUIRED	FLIGHT TIME	EVA REQUIRED	DATA								FILM	DISPLAY DESIRED	DATA DOWN LINK	DATA UP LINK	REMARKS
		1	2	3	4					TELEMETRY				VOICE								
										REAL TIME	RECORDED	OPERATIONAL	DUMPED	REAL TIME	DUMPED							
M466	SPACE SUITS AND LUNAR SURFACE EXPERIMENTS HARDWARE		X			SIVB OWS (AM)	2		NO	NO	7 CHS @ 2 Hz 1 CH @ 30 Hz	NO	BY AM	NO	RECORDED BY AM	YES	O ₂ QUANTITY PLUS DISPLAYS INCLUDED IN M486	AM	AM			
M469	ST-124 REMOVAL AND DIS-ASSEMBLY		X		X	REMOVAL OF IU DISASSEMBLY OWS	2	11 HRS TOTAL 4 HRS IN IU	NO IVA TO IU	NO	4 CHS @ 1 SPS	NO	BY AM	NO	RECORDED BY AM	YES	NONE	AM	AM			
M479	ZERO GRAVITY FLAMMABILITY		X			OWS	1	8 HRS TOTAL	NO	NO	1 CH @ 1 SPS	NO	BY AM	NO	RECORDED BY AM	YES	COMBUSTION AND PRESSURE INFORMATION	AM	AM			
M486	ASTRONAUT EVA ACTIVITIES		X			OWS	2	72 HRS	NO	EST 6 CHS @ 1 SPS EKG @ 200 SPS	6 CHS @ 2 Hz 1 CH @ 30 Hz (FILM)	NO	BY AM	NO	RECORDED BY AM	YES	BATTERY VOLTAGE, SUIT INLET TEMP, SUIT PRESS, TANK PRESS FUEL SUPPLY, FUEL TEMP, FCD PARAMETERS	AM	AM			
M487	CREW QUARTERS HABIT-ABILITY		X			OWS AM	2	ESTIMATED 44 HRS INCLUDING 13 HRS EVA	YES	NO	NDR	NO	NDR	NO	RECORDED BY AM	YES	NONE	AM	AM			
M488	HIGH PRESSURE GAS EXPULSION		X			OWS	2	1 MANHOUR	NO	NO	4 CHS @ 1 SPS	NO	BY AM	NO	NDR	NO	2 TEMP, 2 PRESS	AM	AM			
M489	HEAT EXCHANGER SERVICE		X			OWS	2	16 HRS TOTAL 4 HRS SETUP	NO	13 CHS @ 1 SPS 1 CH @ 4 SPS	SAME AS RT	NO	NDR	NO	NDR	NO	7 TEMPS, 3 PRESS. PARAMETER TO DISPLAY	NONE	AM			

TABLE F-1
EXPERIMENT SUPPORT SUMMARY (4 OF 8)

EXPERIMENT	TITLE	AAP FLIGHT				LOCATION PERFORMED	CREW MEMBERS REQUIRED	FLIGHT TIME	EVA REQUIRED	DATA				FILM	DISPLAY DESIRED	DATA DOWN LINK	DATA UP LINK	REMARKS		
		1	2	3	4					TELEMETRY									VOICE	
										REAL TIME	RECORDED	OPERATIONAL	DUMPED						REAL TIME	DUMPED
M492	TUBE-JOINING IN SPACE		X			OWS	1	1 HR TOTAL	NO	NO	NDR	NO	NO	YES (IF POSSIBLE)	RECORDED BY AM	YES	NONE	AM	AM	
M493	ELECTRON BEAM WELDING		X		X	OWS	1	1 HR TOTAL	NO	NO	NDR	NO	NO	NO	RECORDED BY AM	YES	NONE	AM	AM	
S005	SYNOPTIC TERRAIN PHOTOGRAPHY	X				CSM	1	45 MINS DURING FIRST 5 DAYS	NO	NO	NDR	NO	NO	NO	RECORDED BY CSM	YES	NONE	CSM	CSM	EXPERIMENTS S065, S005, AND S006 USE A COMMON HASSELBLAD CAMERA AND THEIR FINAL DATA COMPLEMENTS EACH OTHER. IT IS SUGGESTED THAT THESE BE PERFORMED DURING FIRST 5 DAYS OF AAP-1 BECAUSE OF CREW ACTIVITY.
S006	SYNOPTIC TERRAIN PHOTOGRAPHY	X				CSM	1	100 MINS (SEE S005)	NO	NO	NDR	NO	NO	NO	RECORDED BY CSM	YES	NONE	CSM	CSM	SEE NOTE FOR S005.
S009	NUCLEAR EMULSION	X				OUTSIDE ON CSM		72-96 HRS TOTAL DURING FIRST 5 DAYS	YES	NO	NDR	NO	NO	NO	NO	NO	TBD	NO	NO	
S015	INFLUENCE OF ZERO GRAVITY ON THE SINGLE HUMAN CELL				X	CSM			NO	NO	NDR	NO	NO	NO	NO	YES	NONE	CSM	CSM	PERFORMED DURING AAP-4 TIMELINE. CARRIED ON AAP-3.
S015A	SURVIVAL OF LIVING ORGANISMS				X	CSM			NO		NDR				RECORDED BY CSM	NO	NONE	CSM	CSM	PERFORMED DURING AAP-4 TIMELINE. CARRIED ON AAP-3.

TABLE F-1
 EXPERIMENT SUPPORT SUMMARY (5 OF 8)
 F-11

EXPERIMENT	TITLE	AAP FLIGHT				LOCATION PERFORMED	CREW MEMBERS REQUIRED	FLIGHT TIME	EVA REQUIRED	DATA						FILM	DISPLAY DESIRED	DATA DOWN LINK	DATA UP LINK	REMARKS
										TELEMETRY			VOICE							
		1	2	3	4					REAL TIME	RECORDED	OPERATIONAL	DUMPED	REAL TIME	DUMPED					
S017	X-RAY ASTRONOMY				X	M&SS	2	22 HRS	YES	NO	2 CHS @ 800 BPS 1 CH @ 10 Hz 1 CH @ 1 SPS 64 BILEVEL CHS @ 10 SPS	ATTITUDE	NO	EVA OPERATIONAL	RECORDED DURING EVA AND ANNOTATION DURING EXPERIMENT	YES	TBD	CSM	CSM TARGET LOCATIONS	TRANSPORTED ON AAP-1 AND PERFORMED ON AAP-4. THIS STATEMENT IS NOT FIRM AT THIS TIME. EVA NOT DEFINED.
S018	MICROMETEOROID COLLECTION	X			X	M&SS ON AAP-1 ATM ON AAP-4	1	8 HRS PLUS EVA	YES	NO	NDR	NO	NO	EVA OPERATIONAL	RECORDED WHILE EVA IN PROGRESS BY CSM	NO	NONE	CSM	CSM	
S019	ULTRAVIOLET STELLAR ASTRONOMY				X	CSM	2	6 2/3 HRS (40 OBSERVATIONS)	YES	NO	1 BILEVEL CH @ 5 SPS	ATTITUDE AND POSITION TIME	NO	EVA OPERATIONAL	RECORDED WHILE EVA IN PROGRESS BY CSM	35 MM SLIDES	NONE			
S020	ULTRAVIOLET X-RAY SOLAR PHOTOGRAPHY				X	AM	1	6 HRS	YES	NO	1 CH @ 1 SPS 1 CH @ 1 SPS	POSSIBLY ATTITUDE	NO	EVA OPERATIONAL	RECORDED BY LM	YES	NONE	CSM OR ATM	CSM OR ATM	
S027	X-RAY ASTRONOMY				X	IU	1	4.5+ HRS	NO	25 CHS @ 4 SPS 60 DIGITAL SERIAL @ 10 SPS	SAME AS REAL-TIME	ATTITUDE	YES 1 PER REV (SEE REMARKS)		NO (EXCEPT TO CUT ON)	NO	NONE	IU	NONE	SUPPORTED WHEN OVER A GROUND STATION. IU HAS NO RECORD AND DUMP CAPABILITY UNLESS PROPOSED ASAP IS ADDED.
S061	POTATO RESPIRATION				X	CSM			NO	POSSIBLY	YES	NO	YES	NO	RECORDED BY CSM	NO	OXYGEN CONSUMPTION	CSM	CSM	VOICE LINK TO CREW CONSIDERED CRITICAL.
S063	ULTRAVIOLET AIRGLOW HORIZON PHOTOGRAPHY				X	MDA (IF MODIFIED)			NO	NO	10 BILEVEL CHS @ 1 SPS	AZIMUTH HEADING	BY AM	NO	RECORDED BY PORTABLE UNIT	YES	NONE	AM	AM	

TABLE F-1
EXPERIMENT SUPPORT SUMMARY (6 OF 8)

EXPERIMENT	TITLE	AAP FLIGHT				LOCATION PERFORMED	CREW MEMBERS REQUIRED	FLIGHT TIME	EVA REQUIRED	DATA				FILM	DISPLAY DESIRED	DATA DOWN LINK	DATA UP LINK	REMARKS		
		1	2	3	4					TELEMETRY			VOICE							
										REAL TIME	RECORDED	OPERATIONAL	DUMPED						REAL TIME	DUMPED
S065	MULTIBAND TERRAIN PHOTOGRAPHY	X				CSM	1	45 MINS (SEE S005)	NO	NO	NDR	NO	NO	NO	RECORDED BY CSM	YES	TIME, CAMERA SETTING, FILTER POSITION DATA, ATTITUDE	CSM	CSM	SEE NOTE FOR S005
T002	MANUAL NAVIGATION SIGHTINGS	X				CSM	2	2 HRS	NO	NO	NDR	NO	NO	NO	RECORDED BY CSM	NO	NONE	CSM	CSM	MANUALLY LOGGED BY ASTRONAUT: SEXTANT READING, GMT OF SIGHTING, GMT OF SUPERPOSITION OF TARGETS, SPACECRAFT VELOCITY'S ALTITUDE, CABIN PRESSURE AND TEMP, ACS FUEL @ SITING AND AT SUPERPOSITION OF TARGET, ANGLE BETWEEN NORMAL AND BISECTOR OF SEXTANT MEASURED ANGLE.
T003	INFLIGHT NEPHELOMETER	X	X			CSM AND OWS	1	12 MINS PER DAY FOR FIRST 20 DAYS	NO	NO	NDR	NO	NO	NO	NDR	NO	NONE	NO	NO	DATA RECORDED IN ASTRONAUT LOG.
T004	FROG OTOLITH				X	CSM		15 MINUTES EVERY 4 HRS UP TO 72 HRS	NO	IF CONVENIENT	4 CHS @ 500 Hz 2 CHS @ 30 Hz 3 CHS @ 10 Hz 3 CHS @ 1 SPS	NO	BY CSM	NO	RECORDED BY CSM	NO	2 EKG'S 2 EEG'S	CSM	CSM	
T017	METEOROID IMPACT AND EROSION		X			EXTERNAL TO MDA	2	NOT DEFINED (CREW ACTIVATION ONLY)	YES	NO	NDR	NO	NO	NO	NDR	SLIDES (SPECIAL)	NONE	NO	NO	EVA MAY BE PERFORMED ON THIS SERIES OR A LATER SERIES OF MISSIONS.
T020	JET SHOES		X			OWS	2	4 HRS TOTAL	NO	NO	NDR	ATTITUDE	NO	NO	RECORDED BY AM	YES	NONE	AM	AM	
T021	METEOROID VELOCITY		X			EXTERNAL TO MDA	2	0.5 HR EVA	YES	NO	5 CHS @ 1 SPS 1 CH DIGITAL SERIAL @ 50 BPS	NO	BY CSM	NO	NO	SPECIAL PANELS	VELOCITY DIRECTION (5 PARAMETERS)	AM	AM	COMMAND REQUIRED TO INITIATE EXPERIMENT.

TABLE F-1
EXPERIMENT SUPPORT SUMMARY (7 OF 8)

EXPERIMENT	TITLE	AAP FLIGHT				LOCATION PERFORMED	CREW MEMBERS REQUIRED	FLIGHT TIME	EVA REQUIRED	DATA						FILM	DISPLAY DESIRED	DATA DOWN LINK	DATA UP LINK	REMARKS
		1	2	3	4					TELEMETRY				VOICE						
										REAL TIME	RECORDED	OPERATIONAL	DUMPED	REAL TIME	DUMPED					
TO22	HEAT PIPES				X	IU				10 CHS @ 1 SPS	NO	NO	NO	NO	NO	NO	TBD	IU	NO	
TO23	SURFACE ADSORBED MATERIAL		X			EXTERNAL TO SIVB	2	1 HR EVA IMMEDIATELY AFTER ORBIT	YES	NO	NDR	NO	NO	NO	NO	SLIDES (SPECIAL)	NONE	NO	NO	COULD BE SCHEDULED IN CONJUNCTION WITH D021. POSSIBLE VIDEO REQUIREMENT.
SO52	WHITE LIGHT CORONOGRAPH				X	ATM	2	EA ACTIVITY 5 MIN 2 WKS	YES	11 ANALOG CHS	11 ANALOGS CHS	EVA	YES	YES	YES	YES	5 ONBOARD PARAMETERS DISPLAYED	CSM OR ATM	CSM OR ATM	1 EVA FOR EACH 7 DAYS OF OBSERVATION (VOICE COMM WITH COGNIZANT SCIENTIST)
SO53	UV CORONAL SPECTROGRAPHS				X	ATM	2	EA OBSERVATION LESS THAN 20 MIN. 2 WKS	YES	8 BPS	8 BPS	EVA		YES	YES	YES	TEMPERATURE AND FILM USAGE	CSM OR ATM	CSM OR ATM	1 EVA FOR EACH 14 DAYS (VOICE COMM WITH COGNIZANT SCIENTIST)
SO54	X-RAY SPECTROGRAPHIC TELESCOPE				X	ATM	2	1 OBSERVATION EVERY 8 HRS	YES	NO	60 CHS FOR HOUSE-KEEPING	EVA	YES	YES	YES	YES	4 ONBOARD PARAMETERS DISPLAYED	CSM OR ATM	CSM OR ATM	1 EVA FOR EACH 14 DAYS (VOICE COMMAND TO INITIATE EXPERIMENT)
SO55	UV SPECTROMETER				X	ATM	1	2, 7 HRS PER DAY 12 MINS PER ACTIVATION	NO	NO	11 CHS @ 800 BPS PER CH 15 ANALOG CHS.	NO	YES	YES	YES	YES	2 OR MORE ONBOARD PARAMETERS DISPLAYED	CSM OR ATM	CSM OR ATM	RT VOICE BETWEEN EXPERIMENTER AND FLIGHT CREW MEMBER
SO56	X-RAY TELESCOPE				X	ATM	2	ONCE EVERY 12 HRS FOR 14 DAYS (45 HRS TOTAL)	YES	NO	12 CHS @ 200 BPS PER CH	EVA	YES	YES	YES	YES	4 ONBOARD PARAMETERS DISPLAYED	CSM OR ATM	CSM OR ATM	RT VOICE BETWEEN EXPERIMENTER AND FLIGHT CREW MEMBER

TABLE F-1
EXPERIMENT SUPPORT SUMMARY (8 OF 8)

TABLE F-2
 DISPLAY REQUIREMENTS FOR AAP EXPERIMENTS

EXPERIMENT NUMBER	CRT	NUMBER OF SS CHANNELS	CRT FORMATS
D017	1	-	1
M050	1	-	1
M401	2	3	5
M402	1	-	1
M423	1	-	2
M464	1	-	1
M466	1	4	1
S017	1	-	1
S047	2	-	4
S052	1	-	1
S053A	1	-	3
S053B	1	-	3
S054	2	-	4
S055A	1	-	2
S055B	1	-	2
S055C	1	-	2
S056	1	-	1
T004	1	4	1
T022	1	-	1

F.3 REAL-TIME EXPERIMENTS REQUIREMENTS ANALYSIS

Experiments requiring real-time support are listed in Table F-2. The following paragraphs contain descriptions and salient points of each experiment. The real-time ground display requirements of each experiment are estimated based on an analysis of the onboard display requirements, real-time down-linked telemetry, and dumped telemetry data. An attempt is made to suggest display techniques for each experiment that can be used by the majority of experiments so that the consoles used in monitoring these AAP experiments can be used most efficiently for the combined AAP support.

F.3.1 Experiment D017: CO₂ Reduction

This experiment is designed to determine the capabilities of a solid electrolyte carbon dioxide reduction system in low "g" environment. The effects of zero gravity on the separation of oxygen from the anode and electrolyte interface will be determined. The parameters of interest for evaluating this experiment are current, voltage, and three temperature and two pressure measurements. The time required to perform the D017 is 4 to 6 hours. Continuous data monitoring of the D017 parameters is required either by ground support or onboard by crew members during this period. Housekeeping data from the environmental control system, i.e., pressure and temperature, is desired with the D017 parameters via the CSM telemetry system.

If the seven D017 parameters are monitored by flight crew onboard and not downlinked, it is required that the data be tape recorded onboard. If data is telemetered in real time, the sampling rates of each parameter is approximately one sample per 10 seconds (0.1 sps).

The data to be displayed onboard is shown in Table F-3.

TABLE F-3
D017 EXPERIMENT DATA SUMMARY

PARAMETER	DATA TYPE	DATA D/L RATE	ONBOARD DISPLAY	ACCURACY (PERCENT)	REQUIRED GROUND DISPLAYS*
ELECTROLYSIS CELL					
CURRENT	ANALOG	.1 SPS	METER	1	METER OR CRT
VOLTAGE	ANALOG	.1 SPS	METER	1	METER OR CRT
TEMPERATURE	ANALOG	.1 SPS	METER	1	METER OR CRT
OXYGEN					
PRESSURE	ANALOG	.1 SPS	METER	1	METER OR CRT
TEMPERATURE	ANALOG	.1 SPS	METER	1	METER OR CRT
CARBON DIOXIDE/ CARBON MONOXIDE					
PRESSURE	ANALOG	.1 SPS	METER	1	METER OR CRT
TEMPERATURE	ANALOG	.1 SPS	METER	1	METER OR CRT
ENVIRONMENTAL CONDITIONS					
PRESSURE	SAME AS OPERATIONAL HOUSEKEEPING DATA				METER OR CRT
TEMPERATURE	SAME AS OPERATIONAL HOUSEKEEPING DATA				METER OR CRT

* THE TOTAL NUMBER OF DISPLAY DEVICES REQUIRED COULD BE AS MANY AS SEVEN ANALOG METERS. HOWEVER, A MORE FLEXIBLE METHOD OF DISPLAYING THIS DATA IS BY DISPLAYING A FREQUENTLY-UPDATED DISPLAY ON A TV MONITOR. ENVIRONMENTAL PARAMETERS CAN BE DISPLAYED SIMULTANEOUSLY FOR CORRELATION WITH EXPERIMENT DATA.

F.3.2 Experiment M050: Metabolic Cost of Inflight Tasks

This experiment will collect the necessary data to evaluate the energy expended versus work accomplished for a given list of tasks. A series of inflight exercises and tasks will be performed by each crew member. The oxygen consumed and carbon dioxide expended during a given time period or on a given exercise or task will be measured and the metabolic rate determined. These values can be compared with the metabolic rates required in normal earth gravity. Data will be collected in the form of voice, astronaut log, and recorded telemetry. It is desired to dump the telemetry at specified intervals.

Periodic flow measurements of expired gas and concentration of O_2 and CO_2 in inspired and expired gas during various activity levels. The rate of these measurements is to be controlled from ground station or spacecraft. The time required to perform this experiment is once each day for each crew member for approximately 10 minutes. The information will be computed inflight and the metabolic rate will be recorded and downlinked via telemetry. The experiment requires ground analysis in real time and post-flight. The parameters used in calculating the metabolic rate are all analog having slow varying signals. The frequency range of the computed metabolic rate is 0.01 to 0.1 cycle per second. A sampling rate of approximately 0.5 sample per second appears sufficient for downlinking the computed metabolic rate.

F.3.3 Experiment M050: Data Summary

An estimate of the ground display requirements is for up to three parameters of slow varying values. These values can be displayed on meters or as tabulations or graphical displays on a TV monitor. For real-time monitoring of this experiment, the TV monitor has the following advantages:

- The experiment is performed periodically over several days and a TV monitor is flexible enough to be used for displaying other experiments' data during non-M050 real-time support periods

- Provides simple methods for interfacing with hard copy machines
- Time history of experiments' data can be included with real-time values.

The data to be displayed onboard is shown in Table F-4.

A sample D/TV display format is shown in Figure F-1.

F.3.4 Experiment M401: Mapping and Survey System

M&SS real-time requirements are not defined. The data rates presented in Table F-1 do not appear to present a severe ground support problem. It is assumed the experiment will photograph its orbital track throughout the first 80 earth revolutions. In order to prove its capabilities in a space environment, it is emphasized that this experiment is on a test and evaluation basis only. It should not impact the mission timeline to the extent that the experiment criteria is binding on the mission timeline or ground support system. Further, the prime source of data collection for the M&SS is the film which is retrieved by an EVA.

The ground display support requirements are not available. The M&SS data is expected to be as follows:

- 3 channels of experiments data (12 sps)
- 1 channel of experiments data (120 sps)
- 88 bilevel channels of experiments data (12 sps)
- 34 channels of housekeeping data (12 sps)
- 3 channels of housekeeping data (120 sps)
- 9 bilevel channels of housekeeping data (12 sps)
- 10 commands are required.

TABLE F-4
M050 EXPERIMENT DATA SUMMARY

PARAMETER	DATA TYPE	DATA D/L RATE	ONBOARD DISPLAY	ACCURACY (PERCENT)	REQUIRED GROUND DISPLAYS
CO ₂	ANALOG	0.1 CPS		-	METER OR CRT
O ₂	ANALOG	2.0 CPS		-	METER OR CRT
COMPUTED METABOLIC RATE	ANALOG	.01 TO 0.1 CPS	2" TO 3" METER	2	METER OR CRT

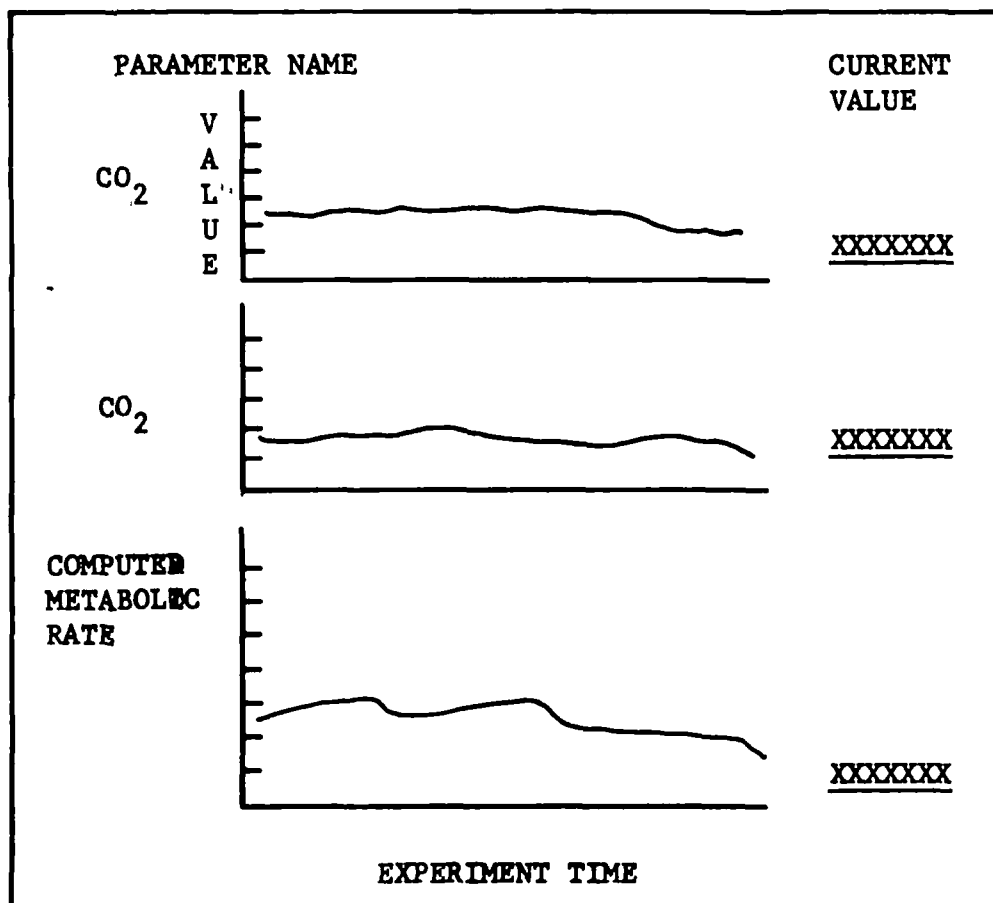


Figure F-1 Example of D/TV Format for M050 Real-Time Monitor

There is an estimated 37 analog channels sampled at a low sampling rate. These parameters might be displayed as one display format requiring one TV monitor. There are three channels requiring high sampling rate. These rapidly changing parameters may require a strip chart or CRT monitor. There are 91 bilevel channels sampled at low rate. These events could be displayed on two TV monitors with each event occurrence being indicated by blinking event name and/or writing out time of occurrence with name. The maximum real-time display requirement appears to be three TV monitors. The experiment parameters having high sample rates may require as many as three strip chart recorder channels.

F.3.5 Experiment M402: Spent Stage Habitability Evaluation

The purpose of M402 is to develop and to demonstrate the feasibility of providing a habitable environment in orbit-using spent vehicle stages and a special airlock. The capability of the airlock will be evaluated for maintaining its environmental control as well as for maintaining the spent stage environment. Measurements of the water and CO₂ concentrations are affected by the astronauts occupation of the spent stage. The SIVB LH₂ tank will be vented before the astronaut leaves the airlock. The LH₂ venting will be monitored by ground control via the IU telemetry system.

Voice, pressure, temperature, and humidity will be analyzed on the ground in real time. This data will be downlinked via the AM telemetry system. This data is considered operational because of crew safety implications, and even though it will be part of the M402 data is not considered as experimental data.

F.3.6 Experiment M423: Hydrostatic Gas Bearing Evaluation

This experiment involves testing gas bearings and is set up in the IU. The maximum time length of the experiment is 7-1/2 hours. Approximately eight channels of telemetry data are required, and this data will be downlinked through the operational data downlink of the IU. The data is stored and downlinked via the dump telemetry system before the IU is inactivated. The data is interfaced to the IU telemetry and recording system. The

parameters to be monitored are expected to be similar to those monitored on operational Saturn AB-5 type gyroscopes. They are expected to include temperatures, pressures, gimbal positions, and gyro speeds. This type data is slow varying and is sampled at one sample per second. This experiment, if monitored in real time, is not likely to require more than one TV monitor.

F.3.7 Experiment M464: Onboard Checkout System

This experiment is designed to prove the feasibility of a centralized, general-purpose OCS. The OCS will perform a factory acceptance level of checkout of spacecraft systems and certain AAP experiments for prelaunch and inflight. The OCS system will be flown on all AAP missions after flight qualification, and the qualifying flight will consist of a series of preprogrammed tests of a closed-loop system. The system will eventually become an operating system to check out spacecraft systems and experiment parameters before and during flight. This experiment requires real-time support.

The OCS may not be performed on this mission. This system would automatically evaluate the readiness of the experiment, i.e., M&SS, M439, and the operational capability of the CSM to support these experiments. If flown on this mission, it will be preprogrammed to evaluate certain experiment and CSM operational parameters to determine their state of readiness, but it would not serve as a basis for performing the experiment. This experiment would be closely associated with the experimental parameters of the M&SS and would be performed prior to accomplishing the M&SS experiment. M464 data must be supported in real time, and operational telemetry data is required as an integral part of the experiment display. The approximate length of experiment is 16 minutes. For real-time support, it is recommended that this experiment be accomplished by split-site support during a United States pass on the first or second revolution after insertion. The orbital altitude of 125 nautical miles assures continuous support from GYM, TEX, KSC, BDA, GBI, and ANT for a 15-minute period.

Real-time ground data analysis is required for 90 minutes per day for ten parameters. The parameters to be monitored are shown in Table F-5.

TABLE F-5
M464 EXPERIMENT DATA SUMMARY

PARAMETER	DATA TYPE	TYPE OF DISPLAY REQUIRED FOR GROUND SUPPORT
DC VOLTAGE	ANALOG	METER/CRT
AC VOLTAGE	ANALOG	METER/CRT
TIME INTERVAL	ANALOG	DIGITAL READOUT/CRT
DISCRETES	2 TO 32 VOLTS	LIGHT INDICATORS/CRT
AC FREQUENCY	ANALOG	DIGITAL READOUT/CRT
CONTACT CLOSURE	LOGIC LEVEL	DIGITAL READOUT/CRT
PCM RATE	BIT RATE	DIGITAL READOUT/CRT
AMPLITUDE	ANALOG	METER/CRT
WIDTH	ANALOG	METER/CRT
RISE TIME	ANALOG	METER/CRT

Fifteen parameters could be displayed on a TV monitor as each measurement point is checked. A sample display format is shown in Table F-6.

As each of the test points is sequentially downlinked, the data could be displayed in the format above by providing the necessary correlation data. One TV monitor is estimated to be the minimum display equipment necessary for supporting M464.

F.3.8 Experiment M466: Suits and Lunar Hardware

The M466 experiment is to evaluate the performance of the EMU, pressure garment, portable life support system, thermal meteoroid garment, and liquid-cooled garment under simulated lunar gravity conditions. This experiment is also to obtain metabolic rate measurements when astronauts are performing lunar type tasks in order to evaluate the EMU support capability and evaluate EMU interfaces with lunar surface type hardware. The Litton suit performance will be evaluated and compared to the EMU performance, and space tools will be evaluated for usefulness for lunar tasks.

The information derived from M466 is metabolic expenditure measurements, timeline analysis, techniques, mobility, space suit and other hardware interactions, and comfort information.

The experiment requires two 3-hour test sessions per day for 2 days. Two astronauts will participate in each test session.

Data from M466 includes written logs, tape recorded voice data, tape recorded biomedical data, and television data. Continuous monitoring is required for the following parameters via recorder.

- Battery Voltage
- Suit Inlet Temperature
- Suit Pressure
- Oxygen Quantity

TABLE F-6
OCS DISPLAY FORMAT

FORMAT NAME	NUMBER
POLARITY	XXXXX
UPPER LIMIT	XXXXX
LOWER LIMIT	XXXXX
ACTUAL VALUE	XXXXX
STIMULUS	XXXXX
MEASUREMENT	XXXXX
TEST	XXXXX
FREQUENCY	XXXXX
SELF-TEST NUMBER	XXXXX
STOPPING TEST NUMBER	XXXXX
TEST POINT	XXXXX
MONITOR POINT	XXXXX
TEST BYPASS NUMBER	XXXXX
DELAY	XXXXX
MICRODATA ASSEMBLY ADDITION	XXXXX
UNITS	XXXXX

- Water Differential Temperature
- Water Quantity
- EKG.

Recorded voice data will be transmitted to the ground and analyzed after the flight. Biomedical data will be stored on tape and returned by CSM. A TV monitor will be provided in the CSM for monitoring activity in the SIVB tank. The TV data will also be transmitted to ground.

One TV monitor in experiments control area could simultaneously display all those parameters, except EKG, listed above. A separate TV monitor would be necessary for actual viewing of the astronauts activities. Video will be available to the control center only if provision is made to add a 4 to 5 megacycle video link from the remote sites to the control center. The EKG data may require a cardioscope or strip chart recorder channel.

POSSIBLE DISPLAY FORMAT FOR M466			
	LOWER LIMIT	CURRENT VALUE	UPPER LIMIT
BATTERY VOLTAGE	XXXXX	XXXXX	XXXXX
SUIT INLET TEMPERATURE	XXXXX	XXXXX	XXXXX
SUIT PRESSURE	XXXXX	XXXXX	XXXXX
OXYGEN QUANTITY	XXXXX	XXXXX	XXXXX
WATER DIFFERENTIAL TEMPERATURE	XXXXX	XXXXX	XXXXX
WATER QUANTITY	XXXXX	XXXXX	XXXXX

F.3.9 Experiment M479: Zero-Gravity Flammability

This experiment will examine the effect of zero gravity on the combustion of various samples of material in oxygen. Specific objectives of M479 are:

- Determine if fire spreads uniformly over an entire exposed surface
- Determine propagation rates in 5 psia oxygen in zero gravity
- Determine the effect of fuel configuration on the combustion process under zero gravity, i.e., size, shape, thickness, solid, foam, or liquid
- Determine effect of various fire extinguishers
- Provide film and spectrometer data of each combustion test.

Film and astronaut observations will be the primary source of data for this experiment. Temperature and pressure of each test will be recorded on film with actual photographs of each combustion. Spectrometer data is recorded. There is no current requirement for experiment data to be transmitted in real time or to be dumped. Film and tape will provide post-flight analysis data.

F.3.10 Experiment S017: X-Ray Astronomy

The purpose of the x-ray astronomy experiment is to accomplish in orbit a high sensitivity scan detection and high resolution recording of celestial x-ray sources and their spectra and energy levels. The information required from the S017 instrumentation consists of the following real-time data:

- 1 channel of audio
- 2 channels of digital data at 800 bps
- 1 celestial time channel at 8 bps

- 1 channel sun shutter at 2 bps analog
- Total of 1600 bits/second for 30 minutes + G&N data

The S017 will require 30-minute data observations to be taken throughout the mission. The S017 data will be recorded at 1.6 kbps and dumped to MSFN at 6.4 kbps. The complexity of S017 requires the transmission of S017 data from the MSFN to the MCC-H where it will be processed and monitored. The maximum time delay of the data transfer between the MSFN to MCC-H will be approximately 6 hours. It is estimated that one D/TV monitor will be sufficient for experiment monitoring. Guidance and navigation data could be provided by flight control to the experimenter for correlation with experiments data.

F.3.11 Experiment S027: X-Ray Astronomy

The objectives of this experiment are to survey a portion of the sky having x-ray sources, with flux values as low as 0.012 counts per cm² per second, to make a spectral analysis of the located sources and to establish if background radiation is real. The S027 equipment will be located in the SIVB/IU. The experiment will be performed during the time the IU has attitude control or approximately 4.5 hours after SIVB/IU-CSM separation. The data from this experiment is to be downlinked via the IU PCM telemetry system.

Sixty digital words will be used for S027 data and housekeeping and 25 analog channels for housekeeping. This data will be telemetered to the ground for post-flight analysis. Telemetry data dump is required once each orbit. The data will be initially signal conditioned and recorded by an ASAP recorder and will be interfaced with the IU PCM telemetry system. The S027 requires the astronaut to command the ASAP/IU PCM telemetry system to dump the S027 data after SIVB/IU-CSM separation. It is not clear how this is accomplished since there is no RF link between the CSM and SIVB/IU. However, the same function might be accomplished by sending the IU telemetry a dump command via the IU digital command system. It should be noted that the S027 does not specify a real-time data requirement. However, since the complete experiment is run in approximately 5 hours after

orbit insertion, the data will be available at remote sites. All the S027 data has relatively low sampling rates, i.e., 60 10-bit words sampled per one sample per second and 25 analog signals sampled per four samples per second. If a near real-time display of data to flight controller or PI were required, it is estimated that one IU monitor would be sufficient for displaying the S027 information.

F.3.12 Experiment S052: White Light Coronagraph

The purpose of S052 is to provide data on the corona polarization and structure in the white light spectrum from 1.5 to 6 solar radii. The objective of performing this experiment is to study the processes occurring in the sun's atmosphere. The S052 utilizes a coronagraph carried in the ATM package on the LM. A maximum of 1 hour per week will be required to perform this experiment. The observations will consist of four exposures each which are less than 5 seconds. Voice is desired between scientists and flight crew. Eleven parameters are to be down-linked by telemetry. Real-time analysis is required on six temperature measurements and one percent film remaining parameter. Analysis is to be made during flight for two analog voltage measurements. This data is also to be returned to earth in tape form. This data can be displayed on one D/TV monitor.

F.3.13 Experiment S053A: UV Coronal Spectrographs (UV Spectroheliograph)

This experiment is to obtain ultraviolet spectroheliograms (150 to 650A⁰) with 2 seconds of spatial resolution and less than 1A⁰ per mm of spectral resolution. The spectroheliogram is to be carried in the ATM package on the LM rack. The S053A will be operated in conjunction with the x-ray telescope, the White Light Coronagraph and the UV spectroheliograph.

Each UV coronal spectrograph observation will be one to four exposures (less than 20 minutes total). One observation every 12 hours will be required in the patrol mode. An active mode will require observations when solar activity of interest takes place. One EVA is required for each 14 days of observation.

The film data will be 200 35 x 250 mm film strips for a 14-day observation period. Observation times will be recorded on the LM recorder (DSE).

Downlinked data to MSFN consists of voice to the cognizant scientist as well as two parameters (temperature and film usage) via telemetry. Onboard S053A experiment displays include aperture cover position indicator, film usage indicator, and out-of-temperature limits indicator.

The real-time parameters of S053A can be easily displayed with S052 on the same display format.

F.3.14 Experiment S053B: UV Spectrograph

The purpose of S053B is to obtain ultraviolet spectral data (800 to 3000Å⁰) of specific points on the sun sufficient to define photospheric and chromospheric structure. This will provide a knowledge of the structure and interactions of the photosphere and chromosphere. The experiment requires four exposures per observation and one observation per day. Each exposure lasts from 10 seconds to 15 minutes.

Data requirements and ground support requirements are similar to S053A.

F.3.15 Experiment S054: X-Ray Spectrographic Telescope

The purpose of the x-ray spectrographic telescope is to obtain high resolution photographs of the sun's surface during periods of high and low solar activity in range of 2 to 10Å⁰. Data obtained from the onboard equipment will be correlated with data gathered by ground-based radio and H_α measuring equipment. The S054 will be run in conjunction with the solar coronagraph, UV spectrometer, and the UV spectroheliograph.

The time required to perform S054 will be one observation per 8 hours plus observations of high activity. Each exposure requires approximately 60 seconds.

The data required from S054 is approximately 1000 feet of 35 mm of film for a 14-day period. A voice link is required with the ground. Fifty to sixty housekeeping data channels may be recorded and dumped to ground stations. A count of S054 specific parameters indicate there are 12 channels sampled at 4 sps and recorded at 1 sps. The real-time specific data is approximately 480 bps.

Approximately 12 parameters will be displayed on ground displays for real-time monitoring. Each have slow data rates and it is estimated that one D/TV could display all of these parameters on one display format. Housekeeping parameters could be displayed on another D/TV monitor. The exact housekeeping parameters to be associated with S054 is not available at this time.

F.3.16 Experiment S055A: Ultraviolet Spectrometers

The S055A is to obtain high spatial resolution ultraviolet spectrograms (1450 to 2250Å⁰) of the photosphere and localized solar active regions. It is operated in conjunction with the x-ray telescopes, UV spectroheliometer, and UV spectrograph. The time required to perform the S055A is estimated to be an average of 2.7 hours per day. Each scan observation will last 12 minutes. The data rate is 400 bps from each of two counters driven by two photodetectors. This data will be tape recorded and possibly dumped via the ATM telemetry system. Voice data is also desired by the cognizant scientist on the ground. Real-time ground analysis is required on housekeeping temperature which is downlinked in real time. Photodetector light intensity is to be downlinked for analysis post-flight. A data scan will require 12 minutes at a rate of 25 sps for three channels or 1200 bps.

Displays required onboard are aperture cover position indicator, out-of-temperature limits indicator, and others not defined.

Ground displays required are approximately five parameters of medium data rates. These could be displayed on one D/TV monitor.

F.3.17 Experiment S055B: Ultraviolet Spectrometers

The S055B is to obtain high spatial resolution ultraviolet spectroheliograms (300 to 1400Å) of 5-minute square areas in the lower corona and upper chromosphere for use in determination of the composition and structure of those areas. S055B is performed in conjunction with the x-ray telescopes, ultraviolet spectrometer, and ultraviolet spectrograph. Each observation will require a 5-minute scan at a rate of 1 to 2 hours per day. Data will be output from eight detectors at a rate of 400 bps each. The output of these photodetectors will be recorded on tape at a rate of approximately 3200 bps. This data may also be telemetered to ground. A voice link is also desired. This data is to be analyzed post-flight. Temperature measurements will be downlinked in real time for real-time analysis of experiment status. This data could be displayed in one D/TV display format.

F.3.18 Experiment S055C: Ultraviolet Spectrometers H₂ Telescope

The hydrogen-alpha filter telescope will provide spectroheliograms of the entire solar disc with a resolution of 1 to 2 seconds. Photographs will be made of the telescope images which are to be compared with vacuum ultraviolet observations made with ground-based hydrogen-alpha equipment. The data from S055C will be used to augment data received from the ultraviolet spectrometer and spectroheliometer provided in the ATM. S055C will be performed simultaneously with either or both S055A and S055B. The time required to perform S055B will be a 1-second exposure every three orbits. Housekeeping data for S055C will be telemetered to earth for real-time analysis. The exact housekeeping parameters required for S055C are not available. It is assumed that S055C will have similar housekeeping requirements and ground display requirements as S055A and S055B. Table D-14 provides a tabulation of data rates and types to be downlinked in association with S055.

F.3.19 Experiment S056: X-Ray Telescope

S056 is to obtain high spatial resolution x-ray (3 to 100A⁰) photographs of the relative intensities of the spectral lines of highly ionized atoms and line brightness distribution across the solar disc. Electron density and temperature is to be calculated from these photographs. The telescope is pointed to within 1 minute of the region of interest and data from two proportional counters are recorded on film and tape with photographs. During the 14-day mission, 45 hours of observation are required. Two modes of observation will be used, i.e., quiet mode (one exposure per 12 hours) and active periods (exposures made as often as once every 3 minutes). Exposure times may be from 1 to 3 minutes. Data from the photoelectric sensors are two channels sampled at 4 sps. Ten analog and five bilevel status measurements are sampled at 4 sps. The total bit rate is approximately 500 bps. These 15 housekeeping measurements and data from the photoelectric sensors can be simultaneously displayed on one D/TV format.

F.3.20 Experiment T004: Frog Otolith Function

The frog otolith experiment is described in detail in Appendix E, Paragraph E.3.2.8.5. The data is desired to be recorded and telemetered to the ground. The data rates are very high but it has been briefly shown in Appendix E that the T004 data can be downlinked via the CSM USB/FM telemetry system in the TV mode. Assuming this data is received by the ground system and is transmitted to the MCC-H the following data needs displaying for cognizant scientist investigation.

<u>PARAMETERS</u>	<u>SPS</u>
2 EKG's from 2 Frogs	100 each
2 Nerve Responses	500 each
1 Accelerometer Measurement	10
1 Temperature	2

<u>PARAMETERS</u>	<u>SPS</u>
1 Pressure	2
1 Time Pulse	1
1 Water Pump Tachometer	2

The EKG signals will require monitoring via display equipment similar to that used for viewing aeromed data. Possible methods which could be used for displaying this data are as follows:

- A cardioscope on an unused aeromedical console could be used for displaying the wideband waveforms of the EKG and nerve responses.
- A second way of providing this frog biomed data is to patch the signals into an oscilloscope which would supplement the experimenters console.
- A third method is to use four channels of strip chart recording in conjunction with an experimenters console.

F.3.21 Experiment T022: Heat Pipe

The purpose of this experiment is to measure temperatures along a pipe to determine thermal flow via a liquid in zero gravity field. This experiment is located in the IU. T022 is activated by the crew, and after temperature stabilization is reached, temperature measurements along the heat pipe are recorded at 5-minute intervals. Time required to perform this experiment is 2 hours. Data which is recorded and dumped or downlinked in real time is as follows. These 10 channels could be displayed on one D/TV monitor.

- 1 Event Channel Heater ON-OFF
- 9 Analog Channels of Temperatures at 10 sps

F.4 SUGGESTED CONFIGURATION FOR REAL-TIME EXPERIMENTS SUPPORT

The AAP, ALSEP, and planned subsequent missions require the MCC-H to progressively handle more experiments data. Real-time monitor and/or analysis of experiment data will be required at the MCC-H in order to provide the necessary experiment ground support functions. Particularly, the principal investigators need a "quick look" capability for determining to what degree their experiment is achieving its objectives and to provide adequate data for determining any real-time corrective actions.

The real-time experiments configuration would provide an Experiments Room in which the PI's could monitor all experiments that are currently in progress. For example, in the AAP time frame, it is quite probable that three ALSEP's will be in progress concurrent with the OWS experiments.

The ALSEP real-time experiments support requirements were defined in PHO-TR268 and PHO-TR273. The OWS real-time experiments support is defined in this appendix. Although these requirements are of a preliminary nature, the capabilities for the suggested real-time experiments support configuration are extrapolated from these. The capabilities for the real-time experiments configuration are presented in the following paragraphs.

The following capabilities are recommended for the real-time experiments support configuration:

- A. Isolate and consolidate experiments display and analysis functions out of the operational environment.
 - B. Provide the PI's with real-time data for quick-look analysis.
 - C. Provide an area for flight controller experiment command and control support that will not perturb the operational command and control functions.
 - D. Provide an area for the experiments system specialists that is separate from the PI's environment.
- .

- E. Provide an experiment interface with the network scheduling and the operational support functions associated with real-time data gathering.

F.4.1 OWS Cluster Configuration Real-Time Experiments Support Requirements

The OWS experiments console must provide the versatility for supporting the diverse experiments associated with the OWS cluster.

Table F-2 summarizes the estimated number of D/TV channels and/or strip chart channels required for each of these experiments. The majority of these can be adequately supported by one D/TV display channel. Experiments requiring the most display data require two D/TV channels. One console having two D/TV monitors would be adequate to support all OWS cluster real-time requirements, since the major experiments will be activated singly and performed one at a time. Should several related experiments be performed simultaneously, such as the ATM experiments, additional D/TV monitors would be required. These would be provided by ceiling monitors controlled from the console.

A request for a desired display format from the AAP experiments console could be via a DRK or an MSK. A DRK could select 384 different formats. An MSK having thumbwheel number dialing could call an even larger number of formats.

The total number of D/TV display formats estimated for the OWS cluster experiments is 40. The maximum number estimated for a given experiment is five. Therefore, the flexibility of the MSK seems to outweigh the advantages of the DRK.

The DRK has a speed of operation advantage over the MSK. However, since the experiments console manned by a given PI will not require access to a large number of display formats, an MSK appears sufficient for requesting displays. The MSK would have the advantage of not having label change requirements.

Four strip chart recorder channels are required for experiment biomedical data recording, i.e., for the frog otolith experiment.

The device having the greatest flexibility and greatest ease for displaying a variety of formats is the D/TV monitor. For this reason, meters are not suggested since reconfiguration of meters from one experiment's parameters to another is unwieldly. Event lights are less difficult to reconfigure if proper programming and label changes are made. However, events, discretes, and time of occurrences could also be displayed on a D/TV monitor and could easily be changed to another set for another experiment.

APPENDIX G
ACRONYMS AND ABBREVIATIONS

AAP	Apollo Applications Program
ACN	Ascension Island
AGC	Apollo Guidance Computer
ALSEP	Apollo Lunar Surface Experiments Package
AM	Airlock Module
ANG	Antiqua
AOS	Acquisition of Signal
ATM	Apollo Telescope Mount
BECO	Booster Engine Cutoff
BDA	Bermuda
CCC	Configuration Control Center
CCU	Camera Control Unit
CNB	Canberra, Australia
COMSPK	Communications Speaker
CRO	Carnarvon
CSM	Command Service Module
CYI	(Grand) Canary Island
DDD	Digital Display Driver
DF	Distribution Frame
DMS	Data Management System
DOD	Department of Defense
DPS	Descent Propulsion System
DRK	Display Request Keyboard

DSC	Dynamic Standby Computer
D/T	Delayed Time
D/TV	Digital-to-Television
EECOM	Electrical, Environmental, and Communications Console
EKG	Electrocardiogram
EMR	Electrical Mechanical Research
EMU	Extravehicular Mobility Unit
ER	Experiments Room
EU	Engineering Unit
EVA	Extravehicular Activity
FCB	Flight Control Branch
FM	Frequency Modulation
FSB	Flight Support Branch
GBM	(Grand) Bahama Island
GDS	Goldstone
G&N	Guidance and Navigation
GNC	Guidance, Navigation, and Control
GWM	Guam
GYM	Guaymas, Mexico
HAW	Hawaii
HL	High Level
HTV	Huntsville (Ship)

IRIG	Interrange Instrumentation Group
ISS	Internal Switching System
IU	Instrumentation Unit
IVA	Intravehicular Activity
KC	Kilocycle
LL	Low Level
LM	Lunar Module
L/O	Liftoff
MAD	Madrid
MC	Master Commutator
MCC-H	Mission Control Center-Houston
MDA	Multiple Decoding Adapter
MDCS	Master Digital Command System
MER	Mercury (Ship)
MIL	Merrit Island
MOC	Mission Operational Computer
MOCR	Mission Operations Control Room
MRSDP	Master Remote Site Data Processor
MSFN	Manned Spaceflight Network
MSK	Manual Select Keyboard
M&SS	Mapping and Survey System
N/S	Near Space

OCS	Onboard Checkout System
OLSS	On-Line Scheduling System
OWS	Orbital Workshop
PBI	Pushbutton Indicator
PCK	Phase Control Keyboard
PCM	Pulse Code Modulation
PFOR	Preflight Operations Room
PI	Principle Investigator
PM	Pulse Modulator
RCR	Recovery Control Room
RED	Redstone (Ship)
RF	Radio Frequency
RFI	Radio Frequency Interface
RFK	Reference File Keyboard
RS	Remote Site
RSDP	Remote Site Data Processor
RTA	Relative Time Accumulator
RTCC	Real-Time Computer Complex
SIVB	Saturn IV Booster
SOCR	Sustained Operations Control Room
SPS	Samples per Second
SSR	Staff Support Room
STTY	Silent Teletype

TAN	Tananarive
TEX	Texas
TIP	Telemetry Input Processor
TLM	Telemetry
TRS	Time Reference Station
UHF	Ultra High Frequency
USB	Unified S-Band
USBS	Unified S-Band System
VAN	Vanguard (Ship)
VDC	Volts Direct Current
VHF	Very High Frequency
VSM	Video Switching Matrix
WPS	Words per Second
ZPG	Impedance Pneumograph